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VOL. 13, Nos. 1-2 JUNE, 1947

Two Decades*

By

B. T. DICKSON,

President of the Institute and Chief, Division of Plant Industry, Council for Scientific and Industrial Research, Canberra, A.C.T.

When considering the kind of address which might be presented on this occasion, my friend and colleague, and our first President, Dr. Richardson, suggested that, as I was completing twenty years of service with C.S.I.R., a review of the two decades would be appropriate. I feel very conscious that pressure of official duties, and other demands on my time, have militated against my devoting the amount of preparation to this address which is really necessary adequately to honour the Institute which honoured me with the Presidency during the past two years.

The Commonwealth Council for Scientific and Industrial Research.

As you know, the Commonwealth Council for Scientific and Industrial Research, popularly known as the C.S.I.R., was formed in 1926 by the reorganization and enlargement of the Institute of Science and Industry. The functions of the C.S.I.R. were defined by the Science and Industry Research Act of 1926, and include research in primary and secondary industries, the training of research workers, making grants in aid of pure research and the establishment of a bureau of information.

In creating the C.S.I.R., the Government followed the example of other advanced countries which recognized that national security and industrial development demand the constant prosecution of research into the many problems facing peoples in these days. In Australia the agricultural and pastoral industries, upon which our welfare so much depends, needed especially the utmost help in the solution of problems confronting them. So it was that during the first decade of its existence, and a very difficult decade it was, C.S.I.R. was mainly concerned with problems in those fields.

At the head of the organization was an Executive Committee with Sir George Julius as Chairman, Sir David Rivett as Chief Executive Officer, Dr. A. E. V. Richardson as third member, and Mr. G. Lightfoot as the very able Secretary. Joined with them was a Council of nine, made up of the six Chairmen of the State Committees and three members, co-opted by reason of their possessing special qualifications. Each State Committee consists of a Chairman selected by the Commonwealth Government, three members nominated by the State Government from the staffs of its scientific departments, three members eminent in science, of whom two at least are members of the staff of the local university, three members associated with industry, and others co-opted by reason of their having special qualifications.

* Presidential address delivered at the annual general meeting held in Sydney on 7th March, 1947.

As you know, Sir George Julius has since died, Sir David Rivett is Chairman, Dr. Richardson Chief Executive Officer, Mr. G. A. Cook Secretary, and the Executive Committee has been enlarged by appointment to it of Professor F. W. G. White, Professor I. Clunies Ross and Mr. D. Mountjoy.

The first Chiefs appointed were the late Professor Brailsford Robertson (so soon to pass away), myself, the late Dr. R. J. Tillyard, Professor J. A. Prescott, the late Dr. J. A. Gilruth and Mr. I. H. Boas (now retired). With the imminent resignation of Professor Prescott from the Soils Division, I feel myself becoming an old identity, as the only remaining original chief in C.S.I.R.

Departments and Organizations Concerned with Agriculture in 1926.

Turning now to the departments and organizations relating to agriculture which existed at the time of the inception of C.S.I.R., there were the State Departments of Agriculture, the Waite Agricultural Research Institute, and in the Commonwealth, the Department of Markets and Transport, the Development and Migration Commission, and the Australian Tobacco Investigation.

The New South Wales Department of Agriculture was headed by Mr. G. D. Ross, as Under Secretary, Victoria by the late Dr. S. S. Cameron as Director of Agriculture, South Australia by Professor A. J. Perkins as Director of Agriculture, Queensland by the late Mr. E. J. Graham as Under Secretary, Western Australia by Mr. (later Dr.) George Sutton as Director of Agriculture, and Tasmania by Mr. F. E. Ward as Director of Agriculture.

Because the first groups of problems which C.S.I.R. undertook were in the agricultural field, it was decided to establish close association with the State authorities, and so the above six men, with the Executive Committee of C.S.I.R., became the Standing Committee on Agriculture for the Council. It is interesting to note this fact, and that this Committee functioned until 1934, when it was reconstituted with additional members into the present Standing Committee on Agriculture.

This Standing Committee usually met twice a year, and discussed such problems as tobacco investigations, bitter pit and related apple diseases, soil surveys, uniform seed testing, wheat investigations, dairy problems, blowfly investigations, animal health problems, and so on. It was natural to expect that each member representing a State Department would be on guard, more or less, to see that this new organization—C.S.I.R.—did not scoop the pool, as it were, and if I may venture to say so, that psychological factor tended to make what was otherwise a splendid committee rather one-sided. I cannot now recall any instance when a representative of the State Departments of Agriculture brought forward a suggestion that C.S.I.R. should undertake a piece of work. Rather it was C.S.I.R. which brought matters forward, and the members criticized the proposals. I should say, in all fairness, that the criticisms were usually useful and to the point. I can still remember Dr. Cameron's hesitancy in speech, which covered an incisive mind and capacity to write beautiful English, Mr. Ross with his quiet approach and obvious administrative outlook, Mr. Graham's very courteous manner and apt use of words, Professor Perkins, the vine and wine expert, with a strong tendency to a literary approach, George Sutton's deep interest in wheat problems, and F. E. Ward's quiet presentation of Tasmania's views. It was a good school for we newcomers to the scene.

In the Universities were Professors R. D. Watt at Sydney, S. M. Wadham, recently appointed to Melbourne, A. E. V. Richardson at Adelaide, Paterson at Perth and J. K. Murray newly at Gatton and Brisbane. These schools were beginning to turn out graduates in greater numbers, but not yet sufficient to meet the demand, and in certain instances students were provided with cadetships in order to ensure their entry into the State Department of Agriculture. What a contrast to the present position, with accommodation for overflowing numbers the acute problem.

In the Federal sphere agriculture was not the responsibility of any department. The nearest approach, and that but incidentally, was in the Development and

Migration Commission, which of necessity had to do with some agricultural problems in connection with the developmental schemes being put forward under the £34 million agreement. The Development and Migration Commission considered, for example, the dried fruits industry, the canned fruits industry, the Murray River basin, fishing and allied industries, tobacco production, the dried apple industry, rural housing and so forth. The foreword to the Second Annual Report of that Commission leads off with a statement which is equally true today, when we are facing the aftermath of the second great world struggle. It reads: "While land settlement schemes are from time to time promoted in inland areas, where productivity of the land is comparatively low and the rainfall light, a considerable proportion of the better land in regions of ample rainfall, well served by railways and the conveniences of civilization, is not yielding as much wealth as it is capable of producing. Over a wide extent of the country in every State there is ample opportunity for increased production at lower costs per unit. Of all the schemes that can be devised for increasing the country's power to absorb and support new population, the most effective is one that will augment the productivity of the lands already occupied."

In the Imperial sphere the Empire Marketing Board, established to help develop the resources of the British peoples, made contributions to C.S.I.R., and to the Waite Agricultural Research Institute, with a view to achieving earlier solutions of some of the problems affecting our agricultural production. At this stage, too, there was the beginning of the Imperial Agricultural Bureaux—Soil Science at Rothamsted, Animal Nutrition at Aberdeen, Animal Health at Weybridge, Animal Genetics at Edinburgh, Agricultural Parasitology at St. Albans, Plant Genetics (except Herbage) at Cambridge, Plant Genetics (Herbage) at Aberystwyth, and Fruit Production at East Malling.

Agricultural Outlook During the Late 1920's.

During the late 1920's C.S.I.R. was busy becoming established and State Departments of Agriculture were heavily committed to their production programmes, which had been greatly augmented during that decade. Wheat monoculture was invading more marginal land, and thereby engendering serious problems in economics and soil fertility, dairying was extending, sugar production had to be limited, dried fruits, citrus, apple, peach and apricot areas were coming into heavy production, all looking to the export market for their continuing prosperity. State Departments of Agriculture were hard pressed to find the requisite numbers of suitable extension officers, and there were increasing demands for the initiation or intensification of investigations into disease and pest control, improvement in varieties and strains of crop plants, pasture improvement, animal health, weed control and other pressing problems.

In New South Wales, irrigation developments especially in the Murrumbidgee Irrigation Area, were to the fore, rice growing was under trial, and horticultural and vegetable crops had been established there. Elsewhere wheat, the major agricultural crop, was creeping westward, with sheep and wool, as the main produce of the pasture areas, and dairying in the coastal stretches. Half the sheep of Australia were in New South Wales.

In Victoria also irrigation areas were receiving considerable attention with respect to dried fruits, canned and fresh fruits, and also pastures for fat lamb raising. Dairying was of special importance; wheat production was advancing into marginal areas; flax growing had been tried with limited response; tobacco growing was in difficulties; and useful work was in progress with strain selection in subterranean clover and rye grasses.

The Bureau of Sugar Experiment Stations in Queensland had done excellent work since the beginning of the century on behalf of sugar production; banana, pineapple, cotton, tobacco, peanuts, soy beans and other tropical crops were being

tried; dairying was developing in new areas and there seemed to be promise for beef cattle production, Queensland having practically half the cattle of Australia.

South Australia, predominantly wheat and sheep country, was producing barley, fresh and dried fruits, and very good citrus. At the Waite Agricultural Research Institute basic work on pasture improvement was in hand with *Phalaris tuberosa*, subterranean clover and the rye grasses.

Western Australia was concerned with wheat production, dairying, fruit growing—mainly apples—wool production and particularly with the possibilities of establishing migrants on dairy farms.

In Tasmania apple production had expanded, but with too great a range of varieties, which led to storage and marketing difficulties. Potato production was well established in the north, flax had been tried, but not with much success, and pastures were being improved for fat lamb raising. The Department was developing a good District Agricultural Office organization.

The Years of Depression.

Entering the 1930's we encountered all the difficulties which fall to the lot of a country depending on the export of primary products for its welfare, and finding that the expected markets are not available because of financial breakdown. There is no need here to do more than express the hope that we will never again see such a world position as obtained during the 1930's.

I propose to refer briefly to two institutions which were established during the depression. In December, 1934, a conference of Commonwealth and State Ministers concerned with agricultural and marketing matters was held at Canberra, and it was then decided to establish a permanent organization known as the Australian Agricultural Council.

The Australian Agricultural Council and the Standing Committee on Agriculture.

The principal objectives of the Council were the promotion of the welfare and development of agricultural industries generally, improvement in the quality of agricultural products, the maintenance of grade standards, and the maintenance of balance between production and markets. With the Council, a permanent technical advisory committee was formed, known as the Standing Committee on Agriculture. It was made up of the permanent heads of the State Departments of Agriculture, the members of the Executive Committee of C.S.I.R., the Secretary of the Department of Commerce and the Director-General of Health.

The Standing Committee is the advisory body to the Council. It was also designed to secure co-operation and co-ordination in agricultural research throughout Australia, to secure co-operation on quarantine measures, and to advise governments thereon, and to advise governments on matters pertaining to the initiation and development of research on agricultural problems. Such an organization has all the potentialities of being a great success, provided that departmental outlook is merged adequately in the wider range of Commonwealth welfare, and by "departmental" I include both Commonwealth and State. In cold fact the organization has not been an unqualified success. This is due to a number of factors. When charged with the responsibility of a State Department of Agriculture, it is very difficult to go to a meeting prepared to accept a view which may be restrictive to some phase of agriculture extant in that State. There has been a good deal of suspicion of the Commonwealth and its works. Consideration of problems has sometimes been too short, and sometimes too long drawn-out. The war made conditions extremely difficult, especially as the Commonwealth had but a scatter of officers trained in agriculture.

The importance of water to Australia tends to focus attention on the use of irrigation water in agriculture, and so the Agricultural Council now has Ministers,

responsible for irrigation, attending the meetings when irrigation matters are under discussion. Similarly, if soil conservation is under another Minister than that of agriculture, such Minister will attend when soil conservation matters are under consideration.

It is to be hoped that now we are settling down to an uneasy peace, the organization can be made to work satisfactorily.

Establishment of the Australian Institute of Agricultural Science.

Turning now to another institution, we go back to August, 1933, when G. de Vahl Davis suggested to the Sydney University Agricultural Graduates' Association that the time was opportune to establish an Australia-wide organization of agricultural graduates and persons who had rendered suitable service to agriculture. Davis was the leader in the discussions which ensued, ably helped by Dr. E. T. Edwards and others, until the evening of 17th January, 1935, when the Australian Institute of Agricultural Science was formally established. I am credibly informed that de Vahl Davis was the first that night to pay the subscription entitling a person to membership, so he was No. 1 member, followed by Dr. Edwards, and then A. J. Vasey.

Our Institute is now twelve years of age, with 587 corporate members and 63 student members in addition. While of necessity we meet as Branches, except on rare occasions, the fact is that we consider our projects from an Australian point of view, and I hope that we will never depart from that principle.

It is good to know that the Institute is honouring de Vahl Davis tonight by placing him in the presidential chair.

Progress in the Agricultural Field During the 1930's.

Despite the difficulties of the period, a considerable range of accomplishment was evident in the agricultural field. The Commonwealth Prickly Pear Board (C.S.I.R., N.S.W. and Queensland) carried to a successful conclusion the control of large areas of the major prickly pear pest by the use of *Cactoblastis cactorum*, thus opening a new province for Queensland.

New South Wales made rice production in the Murrumbidgee Irrigation Area an unqualified success. On the other hand, the impact of the depression led to distressing hardships and disappointments in marginal wheat lands.

In Queensland, tobacco production in the more northerly parts near Cairns was shown to be possible, peanuts were established as a crop, and grain sorghums were being successfully tried.

In Victoria, certified strains of rye grass were developed and fundamental work done on subterranean clover strains.

South Australia continued with work on *Phalaris tuberosa* and improved pastures generally, and a new field was opened by the study of mineral deficiencies in stock nutrition and pastures. Particularly was this so with cobalt, copper and zinc.

In Western Australia another important tobacco area was developed at Manjimup, and in Tasmania the Department established a station for potato improvement at Tewkesbury and reworked most of its apple orchards, using standing stocks to carry scions of desirable market varieties.

Considerable work was done on the blowfly problem, buffalo fly, biological control of St. John's wort, pleuro-pneumonia of cattle, mastitis, entero-toxæmia, foot rot and black disease of sheep ; soil maps of the Murray River settlement and of King Island were prepared. These are but illustrations of the various advances made by State Departments and C.S.I.R. during the period just prior to the outbreak of the Second Great War.

Generally during the period cereal production except for maize tended to rise for various reasons such as better varieties, better cultivation, increased acreage (see Table 1).

There are not in Australia large areas eminently suitable for maize production, such as are to be found in the United States of America, and because of which hybrid maize production has made such strides. Rather, I think this is a country for grain sorghums, and it will be surprising if there is not a significant development of this crop.

TABLE 1.

Cereal production in Australia.

Cereal.	Millions of Bushels. Average for five years ending		Year 1939–40.*
	1928–29.	1938–39.	
Wheat	143·5	154·3	210·5
Oats	14·1	17·0	25·3
Barley	5·8	9·7	15·6
Rice	0·5	2·3	1·9
Maize	9·3	7·7	6·6

* The war year, but recognized to be a record year.

Livestock numbers rose from about 12,290,000 head of cattle and 101 million sheep and lambs to over 13 million cattle and about 120 million sheep. Butter production averaged 282 million lb. for the quinquennium ending 1928-29, and was 475 million lb. in 1939-40. Cheese similarly rose from 30 million lb. to 70 million lb., and the total milk from 800 million gallons to 1,254 million gallons.

The Advent of the Second World War.

Then in 1939 the world was once more plunged into the catastrophe of major war, and soon food production became a crucial problem. The need for Australia to function as a great nation at war demonstrated that in the field of agriculture the Commonwealth was not equipped to play an adequate part because of the lack of trained agriculturists in its service, either as individuals or as a unit dealing with agricultural matters. Numerous boards and committees were established to deal with the various food commodities and phases of production, and rarely was the board or committee led by an agricultural expert. Eventually the Department of Commerce was enlarged to be the Department of Commerce and Agriculture, but even so the whole food control organization very nearly passed under the control of an administrator totally lacking in knowledge or experience of agriculture.

As you know, I have consistently advocated the need for the establishment and full development of a Commonwealth Department of Agriculture charged with the responsibilities which are appropriate to the Commonwealth, and co-operating wholeheartedly with the sister State Departments of Agriculture. I believe that agriculture is so important to our country that the Commonwealth Department should be an entity with its responsible Minister, and not a sub-department.

During the war period, public attention was focussed on the condition of much of our agricultural country, because by reason of our malpractices, soils were losing fertility and thereby were being seriously eroded. Soil conservation units have been established in several States with the objective of developing methods of controlling and preventing erosion loss, and it is generally recognized that proper land utilization is the basis for control whether it be in agricultural areas or in watersheds where afforestation is required. In other words, the control of erosion in agricultural country is inseparable from agricultural practices.

Early in 1943 the Government established the Department of Post-war Reconstruction, and that Department established two bodies of great importance to agriculture.

The Rural Reconstruction Commission.

On 25th February, 1943, the Minister for Post-war Reconstruction, now the Prime Minister, appointed a commission of four to be a Board of Inquiry into

(*a*) the organization of Australian rural economy for the purposes of the defence of the Commonwealth, and the effectual prosecution of the war, including the efficiency of methods of production, distribution and marketing of primary products, and the conservation, maintenance and development of the natural resources of Australia ; and

(*b*) the reorganization and rehabilitation of the Australian rural economy during the post-war period.

The Rural Reconstruction Commission has prepared a series of most valuable reports, as follows :

1. A General Rural Survey.
2. Settlement and Employment of Returned Men on the Land.
3. Land Utilization and Farm Settlement.
4. Financial and Economic Reconstruction of Farms.
5. Rural Credit.
6. Farming Efficiency and Cost, and Factors relating thereto.
7. Rural Amenities.
8. Irrigation, Water Conservation and Land Drainage.
9. Rural Land Tenure and Valuation.

The Commission was under the chairmanship of the Hon. F. J. S. Wise, with Mr. C. R. Lambert, Mr. J. F. Murphy and Professor S. M. Wadham as members. It is a matter of congratulation that a member of the Institute and its President in 1937-8 is a member of that Commission, and all who know him will realize the amount of work that Wadham has put into the preparation of those nine reports.

Agricultural Economics.

The other organization to which I refer is the Bureau of Agricultural Economics, with Mr. J. G. Crawford as its head—again a member of the Institute. Nearly twenty years ago discussions took place between the Government and C.S.I.R. about the possibility of establishing a Division of Economics Research, but the proposal did not go beyond the discussion stage.

The Institute stressed the importance of the study of rural or agricultural economics in considering agricultural problems, whether of production or living. The New South Wales Department of Agriculture took the first real step by establishing a division of Agricultural Economics in 1941, with Mr. Pawley in charge. While the pendulum may have swung too heavily for the time being in the direction of economics, so that economists wield great power today, we do welcome the establishment of this Commonwealth bureau, and feel sure that it will do its share towards stabilizing the agricultural industry on sound economic lines.

The Imperial Agricultural Research Conference of 1927 considered the proposal to establish an Imperial Bureau of Agricultural Economics, and the matter was considered again at the Imperial Agricultural Bureaux Conference held in London in July, 1946. The Conference recommended that the Executive Council of the Imperial Agricultural Bureaux should arrange for the preparation of a memorandum outlining the desirable scope, organization and operation of an appropriate bureau for submission to contributing governments, in order that they may secure opinions from qualified specialists on the desirability of establishing it, and decide whether they are prepared to provide the necessary financial support.

Food and Agriculture Organization.

The one-time isolation of this continent from the rest of the world is now but a recollection. Today we are so closely knit with other nations, whether we wish it or not, that we are compelled to play a part in international affairs. Thus it is that Australia is deeply interested in the United Nations Food and Agriculture Organization. In another sense Australia is intimately concerned with the new organization because, in 1935, the suggestion was made by the then Rt. Hon. S. M. Bruce that " the marriage of health and agriculture " was a necessary preliminary to raising the nutritional standards of the peoples of the world.

The Food and Agriculture Organization was brought into existence after the United Nations Conference at Hot Springs, Virginia, 18th May to 3rd June, 1943, called by the late President Franklin D. Roosevelt. An interim commission was created to prepare a constitution for the proposed Food and Agriculture Organization, and recommended the lines along which it could work. The interim commission presented its report at Quebec in October, 1945, and the Food and Agriculture Organization was established with Sir John Boyd Orr as its Director-General for the first two years. The Australian delegation on that occasion was led by one of our members, Dr. R. J. Noble, with Mr. J. G. Crawford as an associate.

A special session was held at Washington in May, 1946, to discuss the urgent world food problem, and the second session of the Food and Agriculture Organization was held at Copenhagen in September, 1946. At this session the chief concern was the proposal to establish a World Food Board. The Copenhagen Conference decided to refer the matter to a special conference, known as a Preparatory Commission, of sixteen nations, to be held in Washington as soon as possible, which conference should also consider any proposal alternative to the World Food Board. Mr. F. W. Bulcock, who led the Australian delegation at Copenhagen, was the leader at the Washington Preparatory Commission, and his report is awaited with considerable interest.

I bring this review of two decades to a close with the reminder that we have two great responsibilities—to our own people, who gain their living by agriculture, or who depend for food upon the products of the land, and to the world at large, through the United Nations Organization. Our agricultural organization, both State and Commonwealth, should be so constituted and geared that it can function efficiently to meet both responsibilities.

Our Institute should regard it as a worthy objective, always to be prepared to help to achieve that end on behalf of agriculture.

I sincerely trust that during the next two decades the Institute will amply justify the high hopes of its founders by its good works.

(Received for publication, 23rd March, 1947.)

Soil Salinity in the Agricultural Area of Western Australia*

By
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Small quantities of water-soluble salts are a normal constituent of all soils, but in various parts of the world there are areas with soil containing moderate or large amounts—say upwards of 0·2 per cent. These saline soils may be of large extent or may occur only in small local drainage areas, and their natural vegetation is able to tolerate the high concentration of salts in the soil moisture. Most agricultural crops and pasture species are not so adapted, however, and so soil salinity becomes an agricultural problem when naturally saline soils are developed for agriculture, or when normal soils are made saline as the result of changed conditions imposed by man. Soil salinity as an agricultural problem is most frequently encountered in irrigation areas where the accumulation of salts from the irrigation water, or the redistribution of the salts already in the soil, causes trouble. In the U.S.A. it is estimated that the soil in a large part of the 20,000,000 acres under irrigation in the 19 western States contains enough soluble salts to depress crop yields.[2] Losses in crop production due to salinity are estimated at 75 million dollars annually. The problem is of such magnitude that the United States Regional Salinity Laboratory has been established at Riverside, California, to study it.

Soil Salinity as an Agricultural Problem in Western Australia.

Soil salinity is now widely recognized as an agricultural problem, and as an engineering and water supply problem in the agricultural areas of W.A., especially east of the 25-inch isohyet. Irrigation areas at Waroona, Harvey, Brunswick, Roelands and Dardanup, on the west coastal plain, have so far escaped salinity troubles, and with their high winter rainfalls and efficient drainage it is hoped they will never have to face them. It is on non-irrigated farms devoted to cereal growing and sheep raising, in the moderate and lower rainfall areas between the 11-inch and 25-inch isohyets, that the salt problem chiefly occurs (see map, Figure 1).

Its manifestations vary in certain characters in different parts of the agricultural areas. In the 15- to 25-inch rainfall belt, more or less bare salt-affected areas are commonly seen on the drainage lines of the countryside either near the sources of gullies or along their edges, or on extensive flats. In summer and early autumn white incrustations of common salt are frequently seen on these areas. Soil erosion by gullying is often associated with these areas, and it was accelerated by the wet winters of 1945 and 1946.

In the outer wheat belt areas with an annual average rainfall between 11 and 15 inches, soil salinity is partly associated with the broad valleys in which are systems of salt lakes and channels, but it also occurs on high land associated with certain types of soil. There are instances, as for example in the Salmon Gums district and west of Koorda, where soil salinity is a serious problem on farms in the highest parts of the district. In these lower rainfall areas bare caked patches in grass or crop paddocks are frequently due to salt concentration. In some cases the surface concentration of salt causes the surface layer of about an inch to be very loose and fluffy. This is noted especially on the well-known grey powdery calcareous soil associated with morrel (*Eucalyptus longicornis, Euc. melanoxylon* and *Euc. oleosa*).

Considerable concern about soil salinity existed in the 1929-30 period, when investigations by Teakle showed that it was a major factor in the poor wheat returns

* Presidential Address to the W.A. Branch of the A.I.A.S., delivered 3rd May, 1946.

from the Salmon Gums district and that it was likely to prove a similar limiting factor on many of the soils which were intended for settlement between Southern Cross, Newdegate and Salmon Gums in the 3,500 Farms Scheme.[10] In a period of rapid agricultural expansion it was an unpalatable finding for administrators of land settlement schemes. However, its soundness is demonstrated by experience in some districts settled in the decade prior to 1930 ; salt has now become an important soil problem.

After this brief review we may pass on to a more detailed consideration of (*a*) the history of the salt problem, (*b*) the underlying reasons for such widespread soil salinity, and (*c*) the future of the problem and steps necessary to mitigate it.

Figure 1.
Southern portion of Western Australia showing annual isohyets, main rivers, ancient river beds and towns referred to in text. (Map drawn by courtesy of Chief Draftsman, Lands Department, Perth.)

History of the Salt Problem in the Agricultural Areas of Western Australia.

The development of the salt problem is closely related to the development and expansion of the agricultural areas.

In the decade prior to 1900, land settlement in Western Australia began to accelerate and, except for some development in the south-west, most of the expansion was in the Great Southern areas, in the Geraldton-Northampton district, and along

the eastern railway to such centres as Meckering and Tammin. For the most part it was within the 15- to 25-inch rainfall belt. About 1904-05 development went further east into drier country, as for example at Nangeenan, just west of Merredin. The Merredin Agricultural Research Station is part of the Nangeenan agricultural area subdivided in 1904. The wheat belt was steadily expanded and after the 1914-18 war and up to 1930 big extensions occurred in what may be called the outer wheat belt areas, where the average annual rainfall is mostly between 11 and 15 in. Districts such as Lake Grace, Newdegate, Bencubbin, Lake Brown, Salmon Gums, Kulja, Bonnie Rock and the Lakes district were largely opened up during this period.

The salt problem first received serious consideration in connexion with railway water supplies on the Great Southern line and W. E. Wood, Inspecting Engineer of the Railway Department, made notable contributions to its explanation.[12] The increase in salinity of railway water supplies at Cranbrook and Yornaning (between Narrogin and Pingelly) was related to the clearing of vegetation on parts of the catchment areas. In both cases water was being collected in excavated tanks from the surface run-off. The catchment systems were constructed about 1888, but by about 1905, along with other railway supplies, the water from these dams was unsuitable for locomotive boilers. The trouble was remedied by diverting water collected from cleared parts of the catchments and relying on waters collected from areas still in the virgin state. In the case of Yornaning, constructed on the south branch of the Hotham River, much settlement and clearing had taken place between 1896 and 1904. Wood[12] records that about 1897 in the Northam-Toodyay district it was suggested that destruction of the native vegetation turned the water in the creeks salt, and in 1904 he thought salinity was increasing in the Goomalling agricultural area.

The development of saline areas associated with creeks and gullies apparently became quite general as clearing proceeded in the 15- to 25-inch rainfall belt. Thus in 1912 P. V. O'Brien,[4] Engineer for Goldfields Water Supply, discussing soil salinity in a report on the country between Norseman and Esperance, speaks of salinity developing at lower levels after clearing in the Beverley, York and Northam areas as something quite common and to be generally expected. With these occurrences were generally associated changes in the amount and salinity of the ground water. Evidence from farmers in this belt is often expressed in the following terms : When the country was first taken up, water for stock was not easy to find. A few years after clearing, soaks began to develop in the gullies and sometimes on slopes. These provided good stock water, but in later years became too saline. Bare salt patches associated with these increased water seepages became numerous. The water level rose considerably in wells or is now known to be much closer to the surface than it was many years ago before extensive clearing. Dams (excavated earth tanks) in low-lying parts turned salty. An old well at the Avondale Research Station, said to be about 40 feet deep, now overflows at the surface. In some instances, after a lapse of about 40 years saline seepages are now less saline—an important and hopeful sign.

The idea became prevalent that the clearing of timber *along the creeks and larger watercourses* was the cause of the nearby soil salinity, but this is disproved by the death of timber where it has been left in low-lying parts while the higher slopes have been cleared (Figure 2). There are many flats, where the rise in water table and increase in soil salinity is causing the natural vegetation of timber and scrub to be killed and succeeded by the very salt-tolerant samphire (*Salicornia* sp.).

The extent of the areas affected by soil salinity in the 15- to 25-inch rainfall belt is difficult to estimate accurately but fortunately is not very great. In 1925 the Royal Society of W.A. made enquiries which suggested that about 3 per cent. of the areas of the sample farms were affected. Assuming the area to be now doubled, which is probably not an understatement, it is still not great. However, there are

places where the topography of individual farms and their situation in large broad valleys make them subject to severe salt encroachment where a general rise in water table occurs. An example of a large area in which the greater part of a number of farms has become severely affected by soil salinity is provided by the Dongolocking Flats, east of Dumbleyung. This type of salt problem is also developing in lower rainfall areas in the 13- to 15-inch rainfall zone, e.g. Lake Grace and Pingrup.

Figure 2.
Death of eucalypts and scrub in low-lying areas after general clearing of countryside. Dark patches in the foreground are the salt-tolerant samphire (*Salicornia* sp.), which is now colonizing the area. The living trees in the background are on the bank of an excavated dam, now become salty.

In several affected districts in the lower rainfall agricultural areas (11- to 15-inch annual rainfall) the salt problem has received much closer investigation than anywhere in the wetter agricultural districts.

Salt has been a major factor in the extensive abandonment of farms in the mallee lands centred on Salmon Gums, north of Esperance. There are also farms more or less severely affected by soil salinity in the broad valleys which occur throughout the outer wheat belt. Many of these valleys in their lowest parts have salt lakes (usually dry) and channels which are such a notable feature of the low rainfall parts of the southern half of Western Australia.

In these lower rainfall areas soil salinity has often become a serious problem within a few years of clearing of the timber or mallee scrub and without any notable change in ground water conditions—the affected soils were inherently saline. In other cases salinity trouble has developed owing to rising water table on extensive flats, though probably coupled with some inherent salinity. In most cases the land, prior to clearing and judged from existing knowledge, seemed suitable for wheat growing. With regard to Salmon Gums, it should be noted that in 1917 Paterson[5] gave evidence on soil salinity to the Royal Commission on the Mallee Belt and Esperance Lands. From his investigation in the mallee lands Paterson concluded that probably one-half the area was too saline for profitable farming, one-sixth doubtful, and one-third suitable. The Royal Commission chose to discount this scientific evidence and the settlement of the district proceeded, with tragic results.

As mentioned earlier, Teakle's investigations at Salmon Gums in 1929 showed that by that time a severe salt problem existed there. Reconnaissance work in the 3,500 Farms Scheme area, between Southern Cross and Salmon Gums, followed and

then, in 1930, under Teakle's direction, the State Department of Agriculture, in collaboration with the Department of Lands and Surveys, commenced detailed soil surveys of districts where soil salinity was known or suspected to be limiting crop yields. In the 1930-36 period about one and a quarter million acres were examined. The incidence of soil salinity in these districts has been summarized by Teakle,[9] as set out in Table 1.

TABLE 1.

Soil Salinity in Certain Districts of W.A. as Shown by Detailed Soil and Salt Surveys.

District.	Average Annual Rainfall.	Area of Normal Agricultural Soils.*			
		(277)† No Salinity.	(173) Moderate Salinity.	(159) High Salinity.	(609) Total.
	Inches.	Acres.	Acres.	Acres.	Acres.
Lake Brown	11–13	209,826	41,485	41,877	293,188
Cleary	11	6,255	2,322	845	9,422
Lakes District	12–15	89,562	6,625	68,606	183,116
Salmon Gums ..	12–16	284,873	63,446	195,932	544,251

* Scrub plain soils, low-lying lakey soil types, rocks, lakes, etc., are excluded from these areas.

† These figures refer to the number of sites sampled in the survey for the " 3,500 " farms scheme.

It is evident from Table I that saline soils are extensive, but even so all the districts examined have large proportions of their areas with low salinity, even excluding the scrub plain soils which are normally non-saline. Soils of high salinity formed a much smaller proportion at Lake Brown and Cleary than in the Lakes District and at Salmon Gums. All the evidence points to soil salinity being on the whole highest in virgin country in the belt extending east from Lake Grace and Pingrup, past Newdegate and Lake Magenta and the Lakes district to Salmon Gums. Teakle has called this area the Fitzgerald region.[7]

Certain soil types in these lower rainfall districts are very prone to salt troubles. They include the grey snuffy calcareous soils associated with morrel, yorrel (*Euc. gracilis*) and blackbutt (*Euc. Kondininensis*). At Salmon Gums brown and grey heavy crabholey soils—many in the highest parts of the district—are in the same category. In the Lake Brown and associated valleys, brown loamy soils adjoining the salt lakes are often saline, but so too are very similar soils occurring at high levels, often as patches in the scrub plain areas.

Enough has been said to indicate that soil salinity is widespread in the agricultural areas of Western Australia, but it is much more severe in some districts and some topographical situations than others. What are the fundamental reasons behind this? What is the origin of the salts, and why should they concentrate in certain soil types and localities? If reasonable answers can be given to these questions it becomes possible to consider soil salinity as a farming problem in an intelligent way.

Fundamental Causes of Soil Salinity in Western Australia.

To explain the origin of the salt and its distribution through the countryside involves a consideration of geological factors and past and present climatic conditions.

In every case where considerable soil salinity exists in the agricultural areas of Western Australia the main constituent of the water-soluble salts is sodium chloride—common salt. Farmers frequently refer to " magnesia " patches, but no cases have

been found where magnesium salts are the main constituents. What is the origin of the common salt?

When the rocks of the earth's crust weather under the influence of atmospheric and climatic and biological influences to produce soil their minerals undergo some decomposition and produce certain water-soluble salts. These will accumulate in the soil or be washed into the drainage system according to whether the rainfall is light or heavy. Enormous quantities of soluble salts are moved annually in rivers and streams. For instance, Lake Mead, the lake behind the Boulder Dam on the Colorado River in the U.S.A., receives with the annual inflow between six and ten million tons of salts.[2] Mundaring Weir, in the hills near Perth, receives about 13,000 tons of salt annually.[8]

But decomposition of rocks alone does not explain why common salt should be the major constituent. Quite naturally, the sea with its enormous quantities of common salt comes into the picture. About 77 per cent. of the salt in sea water is normally common salt. An area of land which at some stage was beneath the sea might be expected to have salts similar to sea salts in its soils if climatic and drainage conditions did not favour their removal. But sea salts can also reach inland areas as dust and dissolved in rain. Analyses of rain water[8] from many centres in many countries have shown appreciable quantities of sea salts to be so deposited on the land. This is especially so during winter storms near the sea coast, but even in inland centres is quite measurable. Estimations made on water collected from rain gauges at Merredin (150 miles inland) and Salmon Gums (60 miles inland) over a four-year period showed that an average of 16 lb. of common salt per acre per annum was received at Merredin and 27 lb. per acre per annum at Salmon Gums.[8] If none of this returned via drainage to the sea, enough salt would be added in 200 years at Merredin and 120 years at Salmon Gums to raise the salt content of one foot of soil by 0·1 per cent. In 1,000 years, two feet of soil could be raised to 0·4 per cent.—a common figure. Accumulation at such rates for a few thousand years in light rainfall areas would obviously cause soil salinity.

Evidence from Geology.

Now consider some of the past geological and climatic conditions in the southern half of Western Australia. Geologists have always found great interest in the gently undulating topography and low relief of the inland parts of the State. Many of the isolated residual hills of the dry inland areas as well as many of the hills in the higher rainfall areas near the coast are capped with laterite or ironstone. The presence of laterite indicates that at the time of its formation a wet climate with seasonal dry periods prevailed, and that drainage conditions were rather poor. A peneplain existed over vast areas of the State and on this peneplain laterite was possibly much more extensive than now.

After this peneplain was formed the geological evidence indicates that in Miocene times portions of it were submerged beneath the sea. Opinions as to the extent of the submergence differ. Some geologists believe that most of the State south of about latitude 29° was submerged and have explained the origin of the inland salt lakes and the inland topography as due to this submersion. Other geologists have suggested that, from fossil remains at Norseman, now 900 feet above sea level, it seems certain that the southern and western parts at least have been submerged. Clarke[1] has recently stated his belief that most of the southern part of the State below 1,200 feet was probably submerged in Miocene times. Except for a number of large scrub plains and other laterite areas, this would mean the submergence of most of the present agricultural areas. Obviously subsequent uplifts have exposed these areas again as dry land and they have again become subject to erosion.

Considering the geological evidence, and from a study of the physiography and soils in the agricultural areas, the following explanation is advanced to account for the widespread soil salinity.

When uplift first took place after the Miocene submersion, the Great Plateau of Western Australia was not lifted to its present height, but about 500 feet less. The climate was sufficiently wet for active drainage to occur from what are now relatively dry inland areas. Some of the salt lake systems, as for example the Lake Brown-Lake Deborah system and the systems in the vicinity of Kondinin, Lake Grace an Newdegate, were at that time parts of active river systems. It is possible to trace a continuous drainage system from the broad valleys of much of the outer agricultural areas and show that it links up with the present Avon-Swan drainage system in the country east of Brookton.

In this period a considerable proportion of the salt left in the soils and rocks from the Miocene submergence was probably returned to the sea via the drainage systems or was concentrated into the lower-lying parts of the mature valleys which were produced. The country was probably reduced to a base level, which the geologists have referred to as " the Meckering level ". Meckering, lying in the floor of one of these valleys, is now 640 feet above sea level.

Further uplift of the country then occurred, either continuously or in a succession of steps, and the Darling Range and the inland country reached its present elevation. The uplift of the Darling Range area to its present height probably resulted in much more arid conditions on the inland side of the range and in consequence active drainage and erosion became restricted to the areas west of approximately the present 15-inch rainfall line. Streams such as the Avon further dissected the Darling Range and the present inner agricultural areas, but little further stream action took place in present outer agricultural areas. Arid conditions existing in the outer agricultural areas exposed the alluvium-filled stream valleys to desiccation and to wind action, for many of the salt lake systems have dunes and banks on their eastern margins which clearly demonstrate that prevailing westerly or west-north-westerly winds have been an active factor in their formation. The materials blown out of these drainage lines contained appreciable quantities of salt not yet removed by drainage in the previous period, and as parent materials for soils they were therefore inherently saline. The development of a cover of vegetation would also be a factor reducing the amount of water available for leaching salt from the soil to the drainage system, because of the moisture demands of the growing vegetation.

Cyclic Salt and Rainfall.

In addition the deposition of cyclic salt, brought in by the rainfall, must be considered. The character of the rainfall in the present agricultural areas is for the most part not conducive to the completion of the cycle and the return of salt to the sea. In the areas where salt problems are common, the rainfall is of a low intensity per wet day. Most of the areas east of the 25-inch isohyet receive on average less than 30 points per wet day and large parts of the eastern and southern agricultural areas have less than 20 points. By contrast, in the north-west of the State, where the average rainfall is less, the rainfall per wet day is, for the most part, more than 30 points and in some cases more than 50 points per wet day.[6]

This difference in character of the rainfall is reflected in the present drainage systems. In the lower rainfall parts in the southern portion of the State it is only occasionally that sufficiently heavy rains fall to cause a large flow of water into the drainage systems. The active rivers draining to the south coast east of Albany are all short. In the north-west, however, with for the most part less than 10-inch rainfall, there are such large rivers as the Murchison, Gascoyne and Ashburton, which frequently carry very large volumes of water from hundreds of miles inland.

In the agricultural areas, therefore, the salt brought in by the rainfall remains to a large extent in the soil or subsoil under virgin conditions. This applies particularly in the areas with less than 15 in. annual rainfall. The natural vegetation of eucalypts and scrub apparently absorbs a large proportion of the rainfall soon after it falls. In long dry periods it apparently has the capacity to survive on very small

quantities of moisture. When agricultural development commenced, therefore, in Western Australia, the soils and subsoils in many areas contained appreciable quantities of common salt and of the associated salts from sea water and the whole countryside was clothed with vegetation which considerably restricted the movement of moisture through the soil.

Clearing Land for Agriculture.

In any area, an equilibrium or balance exists between the moisture received as rain, and that which (*a*) evaporates directly from the soil; (*b*) is absorbed by the vegetation; (*c*) runs off into the creeks and drainage system; and (*d*) soaks through the soil to reach the ground water. The development of agriculture has interfered with this equilibrium by removing the natural vegetation—one of the important factors concerned. The introduced agricultural plants—mostly annuals—apparently use less of the total rainfall. Consequently, more of the water entering the soil is now free to move other than into the roots of the vegetation. As a consequence, in the 15- to 25-inch rainfall areas a great deal more water finds its way to the lower levels towards the drainage lines and springs and soaks are the result. The moving water carries with it salts which for thousands of years have remained in the subsoil layers. The level of the ground water in valleys rises and comes so close to the surface that the movement of water containing salts to the surface by capillarity can occur and surface concentrations of salt result. It is interesting to note that a similar salt problem has been reported from Tanganyika, in East Africa, and explained in a similar way.[3] Wood, whose work was mentioned earlier,[12] also records soil salinity developing after clearing in depressions on Yorke's Peninsula, South Australia.

In the lower rainfall parts of the wheat belt of Western Australia there is similar evidence of a rising ground water table in some valleys, but there are also certain soil types, especially the grey powdery soils (associated with morrel) and some of the heavy crabholey soils (as at Salmon Gums), in which the large amounts of salt occurring naturally fairly close to the surface under virgin conditions become redistributed after clearing. In many patches on such soils surface concentration occurs to produce the sterile bare patches often found in crop and grass paddocks on these soils. On the other hand, sandy-surfaced soils with clay subsoils which, under virgin conditions, contain considerable amounts of salt in the clay subsoil, show after clearing a marked tendency for the salt to leach to greater depths.[11] On these soils salinity does not become an agricultural problem unless they occur in very low-lying areas where the water table comes close to the surface.

The conclusion is reached, therefore, that the occurrence of salt in the soils of the agricultural areas of Western Australia is the result of past and present geological and climatic conditions, with the natural vegetation holding an important place in determining the distribution of the salt within the soil profile itself and throughout the countryside. Agricultural development has interfered with the natural set-up and the salt problem is an inevitable consequence.

The Future of the Salt Problem and Methods of Handling It.

If it is agreed that the salt problem in the agricultural areas of W.A. is an inevitable consequence of the clearing of the natural vegetation and the development of the countryside for agriculture, then how far is the productivity of affected farms likely to deteriorate through soil salinity, and what steps can be taken to alleviate the position?

Firstly, in the areas with over 15 in. rainfall, it is apparent that an increased proportion of the water falling as rain now finds its way through the soil and towards the natural drainage system. In doing so, salt is concentrated along the watercourses and adjacent flats and in seepage areas, but every year a considerable amount of salt finds its way into the streams and rivers and finally returns to the ocean. Ultimately we may expect a new equilibrium to be reached and many of the present

saline areas may have their excess salt removed from them and will again become suitable for the growth of ordinary agricultural plants. Several cases are known where springs or wells which had become saline have now improved with respect to their salinity and this has occurred within 50 years of the commencement of the development of the country for agriculture. There is therefore good reason to hope that many salt-affected areas at the higher levels and on minor creeks and gullies may, within a reasonably short time, become more or less free of excess salts. It will be necessary, however, to guard against undue gully and sheet erosion in such places.

There are some areas, however, on extensive flats, where a rise in the salt water table has occurred and now that the water table is within five or six feet of the surface salt concentration is very difficult to control and improvement seems to be unlikely.

It has been often suggested that large drains should be cut through the bottoms of some of the main valleys to assist in reclamation, but since the influence of drains on the ground water level is frequently restricted to a few chains each side of the drain, there is no certainty that any great improvement will be brought about unless drains were placed at fairly small intervals. It is unlikely that the value of the land would warrant such expense.

Where whole farms are situated on such flats and serious soil salinity develops, the individual farmer is particularly unfortunate, because his troubles really result from extensive clearing of the watershed which drains into the flat areas with which he is concerned. The Dongolocking Flats east of Dumbleyung afford an example of this state of affairs.

In the lower rainfall agricultural areas with 11- to 15-inch rainfall, a salt problem, aggravated by rising water tables, seems to be getting more common in smaller subsidiary valleys. It is likely to show some increase after a wet winter like 1945 or 1946, because of the increased amount of water which reached the subsoil and lower levels without an opportunity to drain back to the sea. Fortunately, in some areas individual salt lakes scattered through the farms act as an outlet and evaporating area for excess ground water and will serve as a levelling device to prevent undue rise in ground water level (Figure 3). An increased crop of salt on these lakes would represent a removal from the surrounding soils.

Figure 3.
Salt lake acting as outlet and evaporating basin for excess ground water from surrounding areas. Photo taken in February, 1946, shows water still draining into salt-encrusted lake.

In low rainfall areas relatively flat or gently rising areas in the bottoms of broad main valleys often develop a moderate to severe salt problem when used for wheat growing. The general evidence suggests an increasing problem over the past 15 years and no easy solution can be offered. An altered form of land use seems

essential. In these areas there is also a problem at higher levels where certain soil types of inherently high salinity occur. The fact has to be faced that many farms developed and financed for wheat growing are, over large portions, only suitable now for less intense land use, such as grazing ; and even then overgrazing must be avoided.

Though the outlook on some farms is bad, the overall position throughout the agricultural areas calls for no alarm. There is nothing to suggest that a large proportion of farms will ever have a serious salt problem.

The principles to be followed in attempting the reclamation of salty soils are (*a*) the establishment of plant growth to absorb water within the soil and so restrict its movement to the surface carrying salt upwards ; (*b*) the use of salt-tolerant plants ; and (*c*) the promotion of water absorption and good drainage.

For a long time there has existed a belief that salt lands should be left alone—that ploughing them will spread and increase the salt-affected areas. There is no foundation for these beliefs, although, since plant cover to promote water absorption within the soil is advocated, it follows that fallowing salt-affected areas is not advisable. The Department of Agriculture for some years has advocated the breaking up of salt-affected lands, rather than leaving them untouched, and the use of the relatively salt-tolerant Wimmera rye grass to improve the grazing. Of course, the question of economics comes in, but there is no doubt that if many of the salt-affected areas are used only for grazing, without cultivation and without fertilizer, they will continue to deteriorate and will become so bare that wind and water erosion will be the inevitable result. These conditions already exist in some districts (Figure 4).

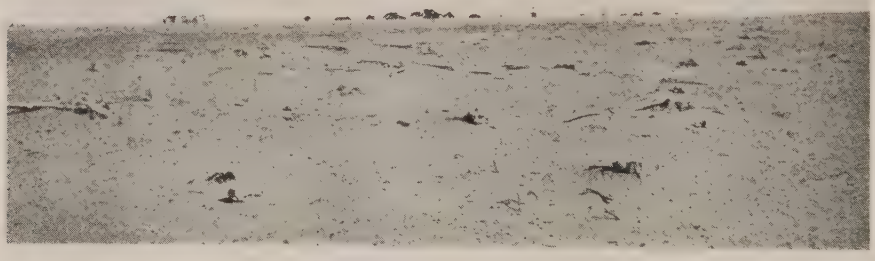

Figure 4.
Wind erosion following an overgrazing of salt-affected land which was retired from cultivation.

Fortunately among farmers and their financiers there is now great interest in methods of handling salt-affected lands. There is less diffidence about revealing a salt problem—in fact there is an embarrassing demand for advice and assistance. Some, but not enough, information is available and a broader issue still remains : How far should the individual farmer be held responsible for, or left to carry the burden of, a salt problem which was inevitable ?

Conclusion.

This final question leads on to the following thoughts. Soil salinity is a State problem, that is, a problem of all the people of the community, not only of the individual whose farm is affected. Financial institutions, with money invested in the farming business, must face their share of unforeseen losses due to soil salinity. On the other hand, the land is a State asset and the farmer, either of his own accord

or at the instigation of his financier, should not be permitted to follow practices which will mine the dwindling productivity of a salt-affected farm and expose it to soil erosion. Agricultural scientists have their part to play in working out suitable cultural methods, crops and pastures for salt-affected lands, and in pursuing fundamental soil investigations which will lead to a more complete understanding of the many aspects of soil salinity in Western Australia.

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United Nations Food and Agriculture Organization

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In outlining the origin, constitution and programme of the Food and Agriculture Organization of the United Nations (F.A.O.), it is unnecessary to do more than briefly refer to the food position as it has obtained in the world and, unfortunately, to a large degree still obtains. It is well known that millions of people never get enough to eat, and that about one thousand million, while not actually on the verge of starvation, do not enjoy a diet which is a minimal requirement for good health. Most of Asia and Central America constitute areas where the nutritional standards are of the lowest order, while North America, Australasia and most of Europe in normal times are areas of high food supplies. The idea of subsisting on a handful of rice daily was brought sharply before us during the war when we learned about the conditions of living of our men taken prisoner by the Japanese.

The great mass of the tillers of the soil the world over are poor in health and resources, and as some 1,500 millions out of 2,200 millions of the world's population are farm people, the task of raising living standards, even by a little, will demand the best efforts of all concerned, individuals, institutions and governments.

The problem is not one only for the less advanced countries –it is equally one for those which, by reason of their techniques and situations, produce surpluses for the international market. Without suitable world action, there is a grave danger that the technically most advanced countries may be forced to repudiate their progress and restrict production to avoid national economic breakdown. We cannot remain static, either we go forward or we go backward.

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The Tragic Thirties.

From the beginning of the century there had been an expanding agriculture in the newer lands by reason of the opening of fertile areas and improved techniques, and this expansion was markedly stimulated by the demands for food during the first world war. In the decade after the war, production in Europe returned practically to normal, and the position was reached where the increased supplies of food could not be purchased. There was an augmented rate of technological advance, both in the production and processing of foodstuffs and in secondary industries, but withal the world was plunged into an economic depression with resulting unemployment and loss of purchasing power.

Extraordinary measures were used by different nations to attempt to meet the situation, reduction of imports, imposition of high tariffs, destruction of produce and restriction of production. It can safely be said that during the 1929-1939 decade the world failed to deal with the situation brought about by the application of science to agriculture and, in fact, most unilateral action made the situation worse.

In 1933 a World Economic Conference was held in London, but it signally failed to evolve a remedial programme.

In 1935 the General Assembly of the League of Nations authorized the preparation of reports on the effect of improved nutrition upon health and also the relation of nutrition to agriculture. It was at this time that Mr. S. M. Bruce, representing Australia at the League of Nations, used the telling phrase " the marriage of health and agriculture ". During the next two years, a mixed health committee of the League of Nations reviewed national nutrition programmes and urged governments to review policies so that food surpluses could be used to improve nutritional standards and help to stabilize agricultural production. Some countries began to implement the proposals, but the second great war intervened.

The Second Great War.

With the outbreak of the second phase of the world conflict, surpluses disappeared almost as by magic, and all efforts were bent to expand the output of foodstuffs as well as munitions of war. Farmers had to use every acre they could and apply the very latest techniques that were available to produce enough, and, even at that, it was necessary to guarantee prices and contract against losses of various kinds. There wasn't enough food to go round, and we had to begin rationing—indeed, we are still rationing foodstuffs.

During the war, production efficiency per individual rose in advanced countries to about 25 per cent. above 1939 rates, and compared with 1919, the improvement is about 70 per cent. With continued improvement in mechanization, disease control, etc., the possibilities of augmented production present a vital problem. We have, in fact, the possibility of guaranteeing freedom from want of food. The question is whether the world can implement that guarantee.

Hot Springs, Virginia, May, 1943.

While the world was still engaged in war, the late President Franklin D. Roosevelt invited interested nations to a conference at Hot Springs, Virginia, to discuss cooperative action on food production and distribution based on the " freedom from want " principle of the Atlantic Charter. The meeting took place from May 18 to June 3, 1943, and 44 nations were represented. There was a full recognition of hazards of production, of the difficulties of world trade and the backwardness of some countries.

Each nation which ratified the Hot Springs Agreement, and Australia was one, agreed to

(1) Raise the levels of nutrition and standards of living of its own people.
(2) Improve the efficiency of agricultural production and distribution.

(3) Cooperate, so far as may be possible, with other nations for the accomplishment of these; and
(4) Submit periodically to other participants, through the permanent organization, reports on the action taken and the progress achieved.

The Conference recommended the establishment of a permanent international organization for the above objectives and set up an Interim Commission to draw the plan of the permanent organization, and also to initiate certain statistical and technical surveys appropriate to the proposed organization.

Interim Commission.

From the close of the Hot Springs Conference until the first session of the United Nations Food and Agriculture Conference held in Quebec in October 1945, the Interim Commission ably prepared the way for F.A.O. It drew up the Final Act and Section reports of the conference at Hot Springs, prepared the First Report to the governments of the United Nations containing a draft of the Constitution of the proposed Food and Agriculture Organization, submitted a report to governments recommending that the International Institute of Agriculture at Rome be merged with F.A.O., prepared a report on Forestry and Forest Products, and finally, one on the work of F.A.O.

The Interim Commission submitted five technical reports on Nutrition, Agriculture, Forestry, Fisheries and Statistics, a series of valuable documents prepared by experts and designed to provide background material for F.A.O., and suggestions for future work. Mr. L. B. Pearson, the Canadian Ambassador to Washington, was the Chairman of the Interim Commission.

In preparation for the First Session of F.A.O., the Interim Commission set up a reviewing panel under the chairmanship of Mr. F. L. McDougall, Economic Adviser to the High Commissioner for Australia in London, to coordinate these technical reports, and prepare a general statement on the proposed scope and functions of the new organization. With characteristic energy and the ability to get people to work, McDougall was able to present a report which materially helped the Quebec conference to proceed to formal establishment of F.A.O.

The First Session of F.A.O., Quebec City, October, 1945.

The Government of Canada invited representatives of the United Nations to meet at Quebec City on October 16, 1945, to sign the constitution and hold the first session of its conference. At the close of the conference on November 1, 1945, 42 countries had become members, as follows: Australia, Belgium, Bolivia, Brazil, Canada, Chile, China, Colombia, Cuba, Czechoslovakia, Denmark, Dominican Republic, Ecuador, Egypt, France, Greece, Guatemala, Haiti, Honduras, Iceland, India, Iraq, Lebanon, Liberia, Luxembourg, Mexico, Netherlands, New Zealand, Nicaragua, Norway, Panama, Paraguay, Peru, Philippine Commonwealth, Poland, Syria, Union of South Africa, United Kingdom, United States, Uruguay, Venezuela and Yugoslavia.

With the formal establishment of F.A.O., the Interim Commission on Food and Agriculture ceased to exist.

It will be of interest to members of the Institute to know the main features of the constitution, and these are selected from the full report of the First Session.

" *Preamble.*

The Nations accepting this Constitution, being determined to promote the common welfare by further separate and collective action on their part for the purposes of:

raising levels of nutrition and standards of living of the peoples under their respective jurisdictions,

securing improvements in the efficiency of the production and distribution of all food and agricultural products,

bettering the condition of rural populations, and thus contributing toward an expanding world economy,

hereby establish the Food and Agriculture Organization of the United Nations, hereinafter referred to as the 'Organization', through which the Members will report to one another on the measures taken and the progress achieved in the fields of action set forth above.

"*Article I* (*Functions of the Organization*).

1. The Organization shall collect, analyse, interpret, and disseminate information relating to nutrition, food and agriculture.
2. The Organization shall promote and, where appropriate, shall recommend national and international action with respect to:
   (*a*) scientific, technological, social and economic research relating to nutrition, food and agriculture:
   (*b*) the improvement of education and administration relating to nutrition, food and agriculture, and the spread of public knowledge of nutritional and agricultural science and practice;
   (*c*) the conservation of natural resources and the adoption of improved methods of agricultural production;
   (*d*) the improvement of the processing, marketing, and distribution of food and agricultural products;
   (*e*) the adoption of policies for the provision of adequate agricultural credit, national and international;
   (*f*) the adoption of international policies with respect to agricultural commodity arrangements.
3. It shall also be the function of the Organization
   (*a*) to furnish such technical assistance as governments may request;
   (*b*) to organize, in cooperation with the governments concerned, such missions as may be needed to assist them to fulfil the obligations arising from their acceptance of the recommendations of the United Nations Conference on Food and Agriculture; and
   (*c*) generally to take all necessary and appropriate action to implement the purposes of the Organization as set forth in the Preamble.

"*Article III* (*The Conference*).

1. There shall be a Conference of the Organization in which each Member nation shall be represented by one member.
6. The Conference shall meet at least once in every year.

"*Article IV* (*Functions of the Conference*).

1. The Conference shall determine the policy and approve the Budget of the Organization and shall exercise the other powers conferred upon it by this Constitution.
2. The Conference may by a two-thirds majority of the votes cast make recommendations concerning questions relating to food and agriculture to be submitted to Member nations for consideration with a view to implementation by national action.
3. The Conference may by a two-thirds majority of the votes cast submit conventions concerning questions relating to food and agriculture to Member nations for consideration with a view to their acceptance by the appropriate constitutional procedure.
4. The Conference shall make rules laying down the procedure to be followed to secure:
   (*a*) proper consultation with governments and adequate technical preparation prior to consideration by the Conference of proposed recommendations and conventions; and

(*b*) proper consultation with governments in regard to relations between the Organization and national institutions or private persons.

" *Article V* (*The Executive Committee*).

1. The Conference shall appoint an Executive Committee consisting of not less than nine or *more than fifteen members or alternate or associate members of the Conference or their advisers who are qualified by administrative experience or other special qualifications to contribute to the attainment of the purpose of the Organization.* There shall be not more than one member from any Member nation. The tenure and other conditions of office of the members of the Executive Committee shall be subject to rules to be made by the Conference.

" *Article VI* (*Other Committees and Conferences*).

1. The Conference may establish technical and regional standing committees and may appoint committees to study and report on any matter pertaining to the purpose of the Organization.
2. The Conference may convene general, technical, regional, or other special conferences and may provide for the representation at such conferences, in such manner as it may determine, of national and international bodies concerned with nutrition, food and agriculture.

" *Article VII* (*The Director-General*).

1. There shall be a Director-General of the Organization who shall be appointed by the Conference by such procedure and on such terms as it may determine.
2. Subject to the general supervision of the Conference and its Executive Committee, the Director-General shall have full power and authority to direct the work of the Organization.

" *Article VIII* (*Staff*).

1. The staff of the Organization shall be appointed by the Director-General in accordance with such procedure as may be determined by rules made by the Conference.

" *Article X* (*Regional and Liaison Offices*).

1. There shall be such regional offices as the Director-General with the approval of the Conference may decide.

" *Article XI* (*Reports by Members*).

1. Each Member nation shall communicate periodically to the Organization reports on the progress made towards achieving the purpose of the Organization set forth in the Preamble and on the action taken on the basis of recommendations made and conventions submitted by the Conference.

" *Article XVI* (*Fish and Forest Products*).

In this Constitution the term ' agriculture ' and its derivatives include fisheries, marine products, forestry, and primary forestry products."

The Conference appointed Sir John Boyd Orr as Director-General of the Food and Agriculture Organization, thereby gaining as its leader an idealist who is also practical, a scientist and an administrator, and one who has devoted his life to advancing scientific phases of nutrition and agriculture.

The work of the Conference was shared by two Commissions, A and B, Commission A dealing with F.A.O. programmes, and Commission B with the administrative and financial side. Commission A set up six committees on Nutrition and Food Management, Agriculture, Forestry and Forest Products, Fisheries, Marketing and Statistics, each of which prepared an expert report with appropriate recommendations totalling about 250 for the group.

The key recommendations called for work on immediate appraisals, on the soundest possible statistical basis, of prewar consumption and production of food, what food consumption targets would make a significant improvement on the health of peoples, what the production and consumption figures are likely to be during the next few years, and the world position for fish, forestry and forest products, and for fertilizers. Many of the recommendations dealt with long-term matters, but, obviously, the serious food position in the world demanded immediate attention.

F.A.O. is not an executive body and cannot purchase, sell or store food stock or fix prices, and so forth. It is an advisory organization designed to collect and collate data, to enquire into and suggest solutions for national, regional or world food problems, to organize technical missions on behalf of member countries desiring them, and generally to help member nations to help themselves to achieve higher standards of production and living. As an illustration of this kind of work, the Government of Greece asked F.A.O. to send a technical mission to study that country's agriculture and fisheries with a view to establishment on sound economic lines, and such a mission was sent.

Commission B dealt, among other matters, with the budget and it may be of interest to know that Australia is committed to provide 3·33 per cent. of a total of 2,500,000 dollars for the first financial year (8½ months) and 2·50 per cent. of 7,500,000 dollars for the second financial year, which is to extend from July 1, 1946, to December 31, 1947.

Special Meeting on Urgent Food Problems, Washington, May, 1946.

It was evident soon after the establishment of F.A.O. that the food shortage would last longer and be more acute than thought originally, and the position was discussed at the United Nations General Assembly in London. Temporary agencies, such as U.N.R.R.A., the Combined Food Board (U.S.A., United Kingdom and Canada) and the Emergency Economic Committee for Europe were of the opinion that F.A.O. should accept the responsibility for getting something done and that responsibility was accepted. A conference was held in Washington on May 20-27 at which representatives of international organizations and representatives of countries having a major contribution to make met to deal with the problem. Six international organizations and twenty-two governments participated. An appraisal of the world food position for 1946-47 indicated that the crisis was likely to continue for at least a year, and probably longer, and that there was likely to be a shortage of some ten million metric tons of grain. The urgent need was to establish a world agency with full authority to allocate basic foodstuffs so long as there is a shortage. To have sufficient world authority, it needed to be more broadly based than the wartime Combined Food Board. This was met by the establishment of the International Emergency Food Council (I.E.F.C.) comprising representatives of nineteen nations to take the place of the Combined Food Board. F.A.O. was invited to be represented on the Council, and was asked to supply the Secretary General and the Secretariat. The Secretariat will furnish trom F.A.O. continuing data on the foodstuffs position in order to aid the Council in arriving at decisions.

The meeting considered ways and means of dealing with the immediate position but expressed its belief that a longer term scheme should be devised to prevent, or at least buffer, in so far as possible, surpluses and shortages which have such grave effects on agricultural stability and the welfare of mankind.

The I.E.F.C. began operations on June 20, 1946, and a central committee of nine was appointed including Argentina, Australia, Canada, China, France, India, Denmark, United Kingdom and the United States of America.

Immediately after the May meetings, Sir John Orr began the preparation of his views for long-term action by a World Food Board. He envisaged the functions of such an institution to be :

1. To stabilize prices of agricultural commodities on world markets, including provision of the necessary funds for stabilizing operations.
2. To establish a world food reserve adequate for any emergency that might arise through failure of crops in any part of the world.
3. To provide funds for financing the disposal of surplus agricultural products on special terms to countries where the need for them is most urgent.
4. To cooperate with organizations concerned with international credits for industrial and agricultural development, and, with trade and commodity policy, in order that their common ends might be more quickly and effectively achieved.

It is obvious that close relations would need to be established between such a Board and the International Bank for Reconstruction and Development, the Economic and Social Council and the International Trade Organization.

The Second Session of F.A.O., Copenhagen.

The Second Session was held on September 2-13, 1946, in the ancient city of Copenhagen at the invitation of Denmark.

During the session, five nations, Hungary, Ireland, Italy, Portugal and Switzerland joined the organization bringing the total membership to forty-seven.

Conference broke into three commissions : Commission A on Technical Questions, Commission B on Organization and Administration, and Commission C on World Food Policy. Commission A set up committees on Agriculture, Nutrition, Forestry, Fisheries, Economics and Statistics, and F.A.O. Missions.

In agriculture, stress was laid on the need to step up fertilizer nitrogen production, the losses in food stocks through infestation, the desirability of international standards for seed certification, the encouragement of producer cooperatives, the need for the establishment of a joint standing committee between F.A.O. and the World Health Organization to deal with rural hygiene, the reorientation of agricultural production as a result of the cessation of war, and the position created by the cessation of U.N.R.R.A. activities on December 31, 1946. An interesting point in the discussion on fertilizers was the passing of a resolution that F.A.O. take steps toward the elimination of the fallacy that crops grown with the rational use of chemical fertilizers may be harmful to humans, livestock or soils.

The Nutrition Committee considered the standardization of food composition tables, diet surveys in relation to family income and expenditure, the most effective use of plant and animal products for human food, food technology, and the nutritional aspects of food production targets.

In Forestry, the main problem is the dire need for timber to meet the world demand for the repair of existing buildings and the construction of new. The shortage is aggravated by the growing demand for wood pulp and for the wood chemical industry. The Committee urged a world wood programme and establishment of regional offices in North America, Europe, Asia with Oceania, and Latin America with Africa.

The Fisheries Committee drew attention to the importance of fish in the diet ; marketing and distribution, surpluses and shortages ; fresh as opposed to frozen fish ; the development of fisheries in under-developed areas and fish prices.

Obviously, a most important group committee was that on Statistics and Marketing. It was recommended that world food appraisal tables be issued annually ; that special attention be paid to problems in the field of fibres, especially wool and cotton ; that F.A.O. should review the need for and uses of international credit for the development of inadequately utilized areas by reclamation, irrigation, control of disease, etc., and, where desirable, encourage the creation of efficient cooperatives. It was strongly urged that F.A.O. should do all it can to promote the 1950 World Census of Agriculture and should urge that where at all possible censuses of forestry and fisheries be conducted concurrently with the Census of Agriculture.

The reliability of the statistics of production, trade and consumption is vital to accurate appraisals, and it was therefore recommended that F.A.O. conduct a survey of the methods in use in the various countries and apprise member countries of the results.

Commission B set up one committee on Constitution and Organization, and one on financial matters.

A draft agreement between F.A.O. and the United Nations was generally endorsed with the proviso that a decision determining the location of headquarters for F.A.O. be deferred to the Third Session in 1947.

It was decided to classify in three categories such non-governmental organizations as may be of assistance to F.A.O. :

1. Important international organizations with interests covering a large part of F.A.O.'s field of activity and of a standing that renders their views on policy a matter of great interest to governments and to F.A.O.
2. Significant international organizations that are interested in the promotion of one or more of the specific aims of F.A.O.
3. International scientific organizations.

Those in category 1 have an observer at the Conference, may have documents bearing on questions, may circulate the organization's views to the Conference, and may, with the consent of the General Committee, speak before Conference. The International Co-operative Alliance, International Federation of Agricultural Producers, and World Federation of Trade Unions were regarded as in category 1. Those in category 2 may be represented at Conference by an observer, have access to such documents as the Director-General sees fit to make available, but cannot speak before Conference. Collaboration with organizations in category 3 may be achieved through arrangements made with the Director-General, and by representation at special technical conferences.

The International Institute of Agriculture will not be taken over until the contributions due from member governments have been received, but the staff of the Institute has been put on the staff of F.A.O. on a temporary basis, and the Institute is functioning as the Rome Office of F.A.O. Implicit in the assumption by F.A.O. of the functions of the International Institute of Agriculture, is the taking from August 1, 1946, of responsibility for a number of conventions : Locust Control, Plant Protection, Marking of Eggs in International Commerce, Standardization of Methods of Cheese Analysis, Standardization of Methods of Analysing Wines, Standardization of Methods of Keeping and Utilizing Herd Books.

Action was postponed with respect to taking over the Centre International de Sylviculture and the Comité International du Bois.

The Committee discussed the importance of developing national F.A.O. committees and the submission of periodic reports dealing with, *inter alia*, implementation of resolutions passed by F.A.O. annual sessions of Conference ; report on other actions taken in the scope of F.A.O. policy ; relation of government with I.E.F.C. and similar intergovernmental organizations set up at the initiative of F.A.O.

Commission C set up two committees, one to consider the recommendations for a World Food Board, and the other to review the 1946-47 world food position.

It was evident that Conference could not deal with all the matters arising in the establishment of a world food agency. There was unanimity about the need for such an agency, concern about the possible repercussions of its activities on national agricultural policies, but nevertheless a desire to do something effective. Conference therefore recommended the establishment of a Preparatory Commission to meet as soon as possible in Washington to carry the proposals further.

The Preparatory Commission was made up of representatives of Australia, Belgium, Brazil, Canada, China, Cuba, Czechoslovakia, Denmark, Egypt, France, India, Netherlands, Philippine Republic, Poland, United Kingdom, United States of

America, with Siam included when rice is under consideration. Because of the great importance of the U.S.S.R. and the Argentine, they were invited to become members.

In addition to governments, the International Labour Organization, World Health Organization, International Bank for Reconstruction and Development, International Monetary Fund, Economic and Social Council, and International Trade Organization were to be represented, but not to vote. The Preparatory Commission was to be under an independent chairman (Mr. S. M. Bruce, now Viscount Bruce, of Melbourne, was chosen by the Executive Committee of F.A.O.) and was charged with considering Sir John Orr's proposals or any alternative proposals which may be submitted, and the preparation of definite recommendations to achieve the objective planned. When the report is finished, it is to be presented to Sir John Orr, who will circulate it to all member governments of F.A.O., and it should then be considered as soon as possible by the F.A.O. Conference.

The Committee which considered the 1946-47 food situation stressed the need to observe economies in the use of bread-grains and to restrict their use for beverages and as feed for animals while humans are short of food. It recommended that F.A.O. and I.E.F.C. issue quarterly reports on the grain position. Finally, it recorded its opinion that it is to the interest of both producing and consuming nations to encourage and plan for maximum production of basic foods during the 1947-48 season.

F.A.O. Committees in Australia.

Both the Quebec and Copenhagen conferences pointed out that for F.A.O. to be successful it must have the active support, not only of governments as such, but of the peoples they represent. It was therefore essential that the F.A.O. be represented in each member country by a national committee which promotes and supports the ideals and programme of F.A.O.

In Australia, it is necessary to have a Commonwealth committee, but because the States are charged with the responsibilities of agricultural production, forestry, fisheries, public health and education, it seems desirable that a committee be set up in each State. The feasibility of the establishment of State committees, their composition and function, is under consideration at the present time.

Conclusion.

The Food and Agriculture Organization came into existence late in 1945, when the world food position was so serious that it demanded immediate attention. At once the Director-General was faced with a dilemma with respect to staff, whether to appoint the numbers needed at once, or to select carefully with a view to the long-term permanent programme. Wisely, Sir John Orr is hastening slowly, and is making considerable use of personnel seconded or loaned by governments or other agencies for specific assignments. Some important appointments have been made, notably the following : Mr. F. L. McDougall and Mr. S. L. Louwes as Special Advisers ; Mr. Gove Hambidge as Director of Information ; Mr. Howard R. Tolley, formerly Chief of the Bureau of Agricultural Economics, United States Department of Agriculture, to be head of the Division of Economics and Marketing ; M. Marcel Leloup, formerly Chief of the Department of Waters and Forests of France, to head the Division of Forestry and Forest Products ; Dr. D. B. Finn, Deputy Minister of Fisheries for Canada, to lead the Fisheries Division ; and Dr. W. R. Aykroyd, Director of the Coonoor Nutrition Research Laboratories in India, to head the Nutrition Division. Unfortunately, it has not yet been possible to appoint a leader for the Division of Agriculture.

The stage is set for the development of the fundamental principles that the welfare of producers and consumers are, in the ultimate analysis, identical, and that no human should be born to suffer from starvation in a world possessing all the knowledge necessary to provide adequate food for all.

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Population and Agriculture of South-East Asia*

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During a visit to British North Borneo in November and December, 1946, the writer had the opportunity of viewing generally the crops and systems of agriculture of South-east Asia.

Quite often, reference is made in the press to the menace of Asiatic races to Australia, and it is a duty to enquire periodically into the economic, social and industrial position of this part of the world. South-east Asia, the portion of Asia closest to Australia, which alone contains 150 million people, is of particular interest to us.

Distribution of Population.

Probably the best index of the present condition of development and the potentiality of this region is the distribution of its population.

The most striking feature of the population distribution of South-east Asia is a variation ranging from the phenomenal population of Java to practically uninhabited areas. The impression of teeming millions received by the visitor to Batavia, Singapore and Bangkok does not apply to the whole of the East. Apart from a few centres of commerce or mining, high population zones are areas of intense agriculture, so that a map recording population density may be read as a map of agricultural development. Such a map is useful also in roughly determining the distribution of fertile soils. In Java and elsewhere in South-east Asia, experience has shown that the most fertile soil types are related to volcanoes. They are found on the slopes of volcanoes and in river valleys, the water and silt of which come from volcanic areas. Further, the soils of highest fertility are only found associated with recent or still active volcanoes and consist of little more than volcanic ash. Many of the older volcanic areas are covered with heavily leached soils of only moderate fertility.

The unusually high population and productivity of Java can be attributed to the large amount of neo-volcanic soils which occur in this island. Although the introduction of European enterprise and capital to Java has resulted in a great expansion, the population of Java has always been relatively high compared with other regions in South-east Asia. In 1860, the population was estimated at 12 million, while a recent estimate is 50 million for Java and 72 million for the whole of the Netherlands East Indies. Java is the most densely inhabited major region of the world.

In contrast to Java, British Malaya, Borneo, Southern Celebes and Western New Guinea are non-volcanic regions, and because of the heavy equatorial rains the soils have been thoroughly leached and crop yields are, on the whole, much less than in Java. The population of these countries is also much less ; for instance, that of British North Borneo, a territory of 30,000 sq. miles (two-thirds the size of Java) does not greatly exceed one-quarter million.

Burma, Thailand and Indo-china also have no active volcanoes, but are able to support dense agricultural populations in some areas because of the existence of extensive alluvial plains, the soils of which are less leached than most alluvial deposits in the equatorial zone. Particularly in those areas of intensive rice cultivation, dense populations are carried, the densest being in the delta of the Red River of Lower Tongking in Indo-china.

* Presidential address to the N.S.W. Branch, delivered 14th February, 1947.

A belt of recent or active volcanoes occurs also on the eastern fringe of South-east Asia, extending from Formosa southwards, through the Philippines to Northern Celebes and Halmahera. In these islands fairly dense populations are also carried, but, with the exception of parts of central Luzon, they do not approach that of Java in magnitude.

Outlook of the People.

The interests of the people of South-east Asia are mainly rural, and for many centuries must remain so because of the struggle for existence on limited agricultural land. There has been some industrialization in Java, and at Singapore and Hong Kong, but the type of secondary industries should be described as fabrication rather than manufacture. Further, there is no evidence that the races that inhabit South-east Asia are martial or warlike, nor should they inspire any fears.

There might be reason to worry if Australia adopted, on sentimental grounds, a policy of allowing immigration of these peoples. At present all that is desirable is for Australia to remain firm in her current national policy.

It is consoling, too, that the agriculture of South-east Asia is not greatly competitive with ours. Its export products are : rubber, sugar, coffee, tea, cocoa, kapok, sisal and manila hemps, cinchona, palm oil, copra and coconut oil, sago, tapioca, spices, cigar wrapper leaf and a number of indigenous forest products. There may be competition from Javanese and Philippine sugar, and, sometime in the future, blends of palm oil and coconut oil may compete with butterfat.

It is reasonable, then, to regard South-east Asia as providing a populous market close at hand for Australia's industrial products, and for such agricultural products as beef and dairy produce. Anything that can be done to raise the standard of living in South-east Asia, and increase its consumption of manufactured goods, should indirectly benefit Australia. Australia has advantages of proximity, but there appears to be urgent need for improvement in our sea transport facilities and knowledge of markets in the East.

Character of Agriculture in South-east Asia.

South-east Asia is one of the great agricultural regions of the world, but the conception of it as an area devoted mostly to estate agriculture or to export crops is an erroneous one. Considerably less than half the tilled land provides export crops, and only a small portion of this is held in the form of estates. Thus, of 33 million acres of cultivated land in Java, only 2½ million are devoted to estate agriculture. Most of the remainder is cultivated by Javanese small farmers for food crops. Many small holders, however, also grow export crops. About 50% of the rubber and most of the coffee, kapok, tapioca, sago and coconut oil are grown by small farmers, who contribute 37% of the agricultural exports of the Netherlands East Indies. Estate agriculture predominates, however, in the production of sugar, tea, palm oil, hard fibres and cinchona.

Most of the crops grown in South-east Asia are introduced from other lands. Coffee and palm oil came from Africa, tea from China and Assam, rubber and tapioca from Brazil, tobacco, maize, sisal, cocoa and kapok from North and Central America, while cinchona came from Peru. Only rice, sugar and manila hemp were cultivated prior to the investment of European capital in South-east Asia.

Considering the heavy equatorial rains with their destructive action on soils, it is fortunate that most of the introduced crops are trees that break the rain and give a good measure of protection to the soil. Nevertheless, soil erosion control is one of the chief agricultural problems receiving attention at present in this part of the world. Wherever possible, permanent cover crops or shade trees are utilized as a shield against the rain and for shading the soil from the tropical sun. In estate agriculture, much use is made also of contoured drains and silt pits, while mulching of some crops, such as coffee, is now receiving attention. The rapid decomposition of organic

matter in tropical soils soon depletes this constituent once the forest cover is removed, sheet erosion carries away much of the surface soil and the frequent and heavy rains leach out soluble plant nutrients. Thus, with the exception of soils derived from recent volcanic deposits, most of the arable soils are heavy clays, if *in situ*, or somewhat swampy, close-textured alluvials. As would be expected, most of them are strongly acid.

Cultivation of Rice.

To the visiting agriculturist the most interesting crop is rice, or padi, not only because it provides the staple food for most of the people, but because in its cultivation survive the arts and implements of an ancient agriculture. The development of the system of cultivation of rice is lost in antiquity, but it is thought to be of Chinese origin. After long study of the methods used, most authorities agree that it would be dangerous to introduce innovations in the system of rice cultivation, as the methods used have evolved in relation to local social and economic conditions, and, primitive as they seem, are difficult to improve upon. Improvement of seed by selection with further selection of varieties on a locality basis appears to be the only big contribution modern science has made to rice culture. Many millions of acres are devoted to rice in South-east Asia, and the crop is to be found wherever there is human habitation. In 1939, a drive to produce more rice was made in Java, and 11 million acres or 15,000 square miles (one-third of the total area of the island), was sown to rice. A record crop of four million tons was obtained, almost the whole of which was consumed locally.

There are two main systems of padi cultivation, the wet system and the dry system, the wet system being by far the more important. There are numerous variations of both systems to meet local conditions.

The general procedure in the cultivation of wet padi is to plough the land once or twice and harrow and smooth it with a scraper or roller. The seed is planted in a nursery and transplanted to the field after 30-40 days. Several seedlings are planted per hill, which are spaced about one foot apart each way.

In dry padi production the land may be ploughed, or if a forest clearing is being used, the seed is dribbled by hand in rows, or it is sometimes broadcast and raked in.

Most soils on which padi is grown are stiff clays. The peculiar suitability of heavy soils to rice culture is associated with the unusual ability of the plant to utilize ammonium nitrogen better than nitrate nitrogen. Also, for wet padi cultivation, heavy clay soils hold water better, and the dykes are easier to construct and are more permanent. However, there are a vast number of varieties of rice differing in their responses to the environment, so that any fertile soil in the appropriate climate can be used for this crop.

The care expended on wet padi is probably greater than that used in the cultivation of any other major crop. Usually, a type of "floating" seed bed is prepared by cutting down grass and weed growth and piling it in long strips 3-4 feet wide until the pile stands a few inches above water level. Sufficient clay is plastered on this foundation to convert it to a compact bed, and on top of this is placed a thin layer of mud and organic matter. Should the level of the water in the field rise, the nursery rises also and thus maintains its surface above water level. In the Philippines, somewhat similar nurseries are constructed on a foundation of suitably arranged banana leaves.

The padi seed is soaked in water for about three days, and then spread out in the shade until it germinates. The germinated seed is broadcast thickly and evenly on the seed bed. The seed is then protected from birds and the sun by a layer of leaves, which are removed after about ten days. When the plants are 6-8 inches in height, they are pulled up in clumps of 150-200, and the clumps are planted so that their stems stand in a few inches of water.

A second transplanting takes place about ten days later, when each large clump is subdivided into smaller clumps and set in water. After another ten days or so the seedlings are finally transplanted to the field.

In the meantime, the permanently dyked field, which is covered with a couple of inches of water, has been carefully prepared by shallow ploughing and puddling with a variety of implements to a gruel-like consistency. Buffaloes or cattle provide the draught. Before ploughing, weed growth is cut down by a double-edged knife mounted on a long handle (*tajak*), which is swung from the shoulder with a downward sweep reminiscent of a golfer's action. The cut vegetation is allowed to rot *in situ*, and doubtlessly contributes valuable organic matter to the culture.

The seedlings are pulled from the nursery with soil adhering, tops are trimmed, and then in some districts the seedlings are dipped in mud and cow dung, or in mud and bat guano or phosphate. Planting in the field is carried out almost exclusively by women, who dibble the seedlings in rows by means of a forked rod, or press them into the mud by hand.

The young padi plants make rapid growth which helps to stifle weed growth, but usually some hand weeding must be carried out. The water is drained off gradually as flowering commences, and complete drainage takes place as soon as the grain commences to ripen.

All harvesting is done by hand. In some areas a serrated sickle is used, the sheaves being dried before being threshed by hand over a tub. In most districts uneven ripening of the crop and the padi bird pest lead to each individual head being cut with a crescent-shaped knife as soon as it is ripe. The bundles of ears are then threshed by the grain being trodden out.

The Oil Palm.

The oil palm (*Elæis guinneensis*) is a native of West Africa, and in recent years has been widely planted in Sumatra and Malaya.

The fruits from which the oil is extracted are about the size of loquats, and are borne in the axils of the leaves in large, compact, ball-like bunches which may weigh 100 lb. or more. Six or eight bunches may be carried on the one plant at the same time. Two types of oil are obtained from the fruits ; the palm oil of commerce is extracted from the fleshy pericarp of the fruit, and palm kernel oil is obtained from the kernels of the nut.

Palm oil is widely used in soap manufacture to give permanence to the lather, while palm kernel oil is used in margarine manufacture and as a source of Vitamin A in medicinal oils. Palm kernel oil is pale yellow in colour, which partly accounts for its use by margarine manufacturers, who seek a natural colour resembling that of butter.

The palms are raised from seed in nurseries, and, when large enough, are planted out 30 feet apart, giving 55 plants per acre. Soils similar to those used for coconuts are chosen so that most oil palm estates occur on coastal areas. The palms come into bearing in their fourth year, and reach full bearing in about ten years. The bunches of fruit are harvested just as they ripen, and are stacked on racks in collecting sheds for a few days to detach the fruits from the bunch. The fruits are conveyed to a factory, where they are boiled to destroy a fat-splitting enzyme they contain. They are then digested under steam pressure for 30 minutes to rupture the oil cells and free the nuts. The digested fruits are then transferred by chute to a centrifugal extractor and treated for about fifteen minutes. Various methods are used to separate the oil from the water and sludge, the most modern being a De Laval separator.

The residual pericarp tissue and nuts from the centrifugal extractors are conveyed to a rotary drier. After drying, the nuts are screened out and, when cool, are cracked in a centrifugal nut cracker. The kernels are separated from the shells by flotation, and the kernels are dried in the sun. The kernels are usually exported as such.

The yield of oil from palm fruits is about 31 per cent. palm oil and 7 per cent. kernel oil. The annual yield per acre of plantations in full bearing is about 1,800 lb. of palm oil and 450 lb. of kernels.

Growth of the Manila Hemp Industry.

The object of my visit to British North Borneo was to investigate a disease of manila hemp or abaca. As the cultivation of this crop is practically confined to South-east Asia, a brief description of the industry will be given.

The cultivation of manila hemp on a plantation scale commenced early in the nineteenth century in the Philippine Islands. The plant from which the fibre is extracted, a species of wild banana (*Musa textilis*), is indigenous to this region. The great value of the fibre for marine cordage was soon recognized, and, by 1900, the annual export of fibre from the Philippines approached 80,000 metric tons. By 1910 this figure had reached 130,000. In 1940, 177,000 metric tons were exported as well as about 10,000 tons of manufactured cordage.

In the Philippines the fibre is produced under a wide range of conditions. There are thousands of small abaca plantations in the foothill regions of southern Luzon, the Visayan Islands and northern Mindanao. When the plant matures, the fibre is cleaned with a crude hand-stripping apparatus, dried in the sun and usually sold to Chinese middlemen, who, in turn, sell to the large exporting firms. In the southern part of the Philippines, particularly in the province of Davao on Mindanao, many large and efficiently operated abaca plantations or estates have been developed during the past 30 years by Japanese companies and settlers. Modern systems of cultivation and cover cropping are practised here, while the hand-stripping method has been replaced by the use of small machines (hagotans). On some of the estates, large automatic fibre extracting machines have been devised. In 1938 there were about 700,000 acres of hemp in the Philippines, but Japanese broadcasts during the war indicated that many abaca fields had been replaced by other crops, so that the present position is not clear.

Attempts have been made to grow abaca in other tropical countries, but most experimental plantings have proved unsuccessful, and, before the war, the virtual Philippine monopoly of hemp was still firm. Plantations have been established at various times in India, the Andaman Islands, Java, Sumatra, Celebes, New Guinea, Panama, British North Borneo, Malaya, Solomon Islands and elsewhere, but except in plantations in British North Borneo, Sumatra and Panama the crop does not seem to have thrived.

The soil and climatic requirements for hemp production are much more specialized than those for the banana. For optimum development a fertile and well-drained soil is required in a continuously warm, moist climate. The plant will not tolerate either swampy conditions or drought, so that tropical regions that have a pronounced dry season are unsuitable. When alluvial land is used it must be well drained.

During the war the United States Government pushed on the production of manila hemp in central America, and by the end of 1943, 26,615 acres of plantings had been made : 11,472 acres in Costa Rica, 5,713 acres in Guatemala, 5,012 acres in Honduras, and 4,415 acres in Panama. The American plantations were developed with the progeny of abaca suckers especially imported to Panama from Davao in 1925 by the United States Department of Agriculture, just before the Philippine Ordinance prohibiting the export of abaca suckers was introduced. The U.S. plan in 1944 was to develop a total of 40,000 acres, with an expected yield of 50-60 million lb. of fibre. Considerable advances are reported to have been made in U S.A. in developing capacity fibre cleaning machines.

The area planted to manila hemp in British North Borneo is not large. Commencing about 1930, a number of estates were developed by Japanese companies and settlers, as had happened earlier in Mindanao. In 1938 the area under hemp was about 8,000 acres and the production 1,267 tons of fibre. Although small, the area is

regarded as important, as it is the only such area in the British Empire, and there is a prohibition on the export of further planting stock from the Philippines. The hemp estates are all located on the north-east coast of the colony on the Semporna Peninsula, where a belt of volcanic soil occurs in a region of evenly spaced rainfall.

Bunchy Top of Manila Hemp.

The hemp acreage has been greatly reduced recently by an outbreak of bunchy top, the same virus disease which, some years ago, almost wiped out the banana industry in New South Wales and southern Queensland. Bunchy top of manila hemp has been recognized as a serious disease in the Philippines for a long time, but there has been doubt concerning its identity with the banana disease. This doubt arose because the hemp disease was not observed attacking Philippine bananas, and experimental attempts to transmit it to bananas were unsuccessful. It is thought that the identity of the two diseases can now be accepted, since in the present outbreak in British North Borneo bananas growing in the hemp estates are occasionally found infected with bunchy top. The banana variety concerned, however, displays a much higher degree of field resistance to infection than does hemp.

Bunchy top first made its appearance in hemp in British North Borneo in 1940, and it has spread to all estates on the southern side of the Semporna Peninsula. There is, however, one estate of about 2,000 acres on the northern side of the peninsula still free from the disease, and as this area is isolated by 24 miles from the infected area there is hope that the industry can be re-established following eradication of the infected area. Unlike bananas, infected hemp is not an immediate total loss, and much valuable fibre can be harvested as eradication proceeds.

Stabilization of Agriculture in South-east Asia.

The world prices of rubber, sugar, coffee, tea, etc., fluctuate a great deal, leading to booms and depressions and general uncertainty. The factors which determine these fluctuations are, of course, largely supply and demand, but interruption of transport and the activity of speculators also play a big part. During the last decade or too much thought has been given to ways and means to bringing about stability in export commodity prices, and there has been a considerable amount of experimenting with control systems in N.E.I. and Malaya. From this has emerged strong support for a plan of international agreements covering all raw materials. The general idea is for the agreements to bind the governments of the principal producing and consuming countries to a scheme of production control to level out sudden price fluctuations and to relate prices to costs of production. Where possible, quotas and rates of production will be set and efficiency of methods scrutinized. The consumer countries are to benefit because of a steadier flow of the commodity at a price which is agreed upon. The plan would provide for buffer stocks to be built up on a joint account to overcome seasonal influences.

The successful operation of international agreements of this type could greatly benefit South-east Asia, where periods of prosperity and depression alternate more frequently than in any other part of the world. Prior to the war, some progress had been made towards the general acceptance of the principle involved, as was shown by the International Sugar Agreement of 1937, to which 25 consuming and producing countries were signatories. Earlier, in 1933, an International Tea Regulation Agreement between tea producing countries was signed, but this would appear to be more of an arrangement to establish an agricultural cartel than one to benefit everyone.

The principle of international agreements covering raw materials and staple foodstuffs is likely to occupy much attention in the future, particularly at U.N.O. and F.A.O. conferences, and there would appear to be no better place to study previous organization and failures than in South-east Asia.

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Rural Reconstruction Commission

A SUMMARY OF THE EIGHTH REPORT.

Looking to the future of agricultural development in Australia, the Rural Reconstruction Commission, in its eighth report, has rightly placed strong emphasis on irrigation as one of the most important potential forces in achieving both advancement to high levels of primary production and stability in various aspects of the industry. There is, for example, a strong connexion between the stabilization of fine wool production in low rainfall regions and fodder conservation under irrigation as an ameliorant of the effects of drought. The strengthening of the fat lamb and dairying industries is tied to high quality pastures and these are best maintained under irrigation. Intensification of the newer development in areas of high rainfall may be held back due to problems such as soil poverty or deficiency or costs of farm establishment. The firm foundation of irrigation areas becomes of national importance and water conservation and distribution is therefore a matter for national planning.

The Eighth Report of the Rural Reconstruction Commission sets out to discuss the question of the conservation and use of water resources in Australia and the problems attendant on such developments. The keynote is in the opening of Chapter 2 on the allocation of Australian water supplies that " water will ultimately be one of the most important of all commodities in the Australian economy ". It may be noted that it is not only the agricultural economy but the whole Australian economy which is involved, that is, implying the basic nature of primary industry not only for the present economic salvation of the country but as governing directly the extent of increase of the population.

In the following review the subject matter has been dealt with under the headings used in the Commission's report.

Allocation of Australian Waters.

There is a very wide range in the efficiency of river catchments in Australia as affecting the run off of waters to rivers and dam storages. The range quoted from 4 per cent. to 62 per cent. of mean annual rainfall calculated as being discharged into streams indicates the desirability of research into the conversion of catchment areas into effective collectors and distributors of water. The Commission recommends this specifically, and it is clear that a team of investigators, made up of engineers, foresters, agronomists and soil scientists, should be organized for the study of conditions on selected catchments with a view to improving run-off and controlling erosion. The Australian river catchments suffer from the uncertainty of rainfall characteristic of many parts of the Continent, and statistics show there are no comparable possibilities of water conservation to those existing in America or India. In practice most of the sound irrigation schemes in the world rely on snow-bearing catchments, which are severely limited in Australia. And in any case the quantity of water passing down our snow-fed rivers is erratic, as a study of the flows in the Murray and Murrumbidgee Rivers shows.

An interesting series of maps and tables compiling the known data on watersheds and river storage schemes in the mainland States is presented. The obviously richest States in usable water resources are New South Wales and Victoria. New South Wales has an effective planned storage on all rivers (including the Snowy River) of over five million acre-feet, of which about 20 per cent. is proposed for use for stock and domestic supplies only and the balance for irrigation and stock supplies. Hydro-electric schemes are usually associated with the storages except on the North Coast, where, as irrigation is not concerned, they are separately designed. Victoria has made exceptionally good use of her rivers, and controls over $3\frac{1}{4}$ million stored

acre-feet for irrigation or stock and domestic supplies. The compactness of the State and the number of usable rivers assist in this utilization, which is nevertheless very extensive. Queensland is a peculiar case for which there is insufficient information, and as the storage is dependent on heavy rains in a concentrated wet season it would seem the attack must be very different from that on the snow-bearing catchments of south-eastern Australia, and for the same reason it is unlikely, with few possible exceptions, to be as sound. South Australia has poor potentialities except for a more extensive use of the Murray River waters at present allotted to the State. A mention is also made of a possible use of underground water in the south-east of South Australia, but this is discounted by an implied excess of soluble salts in the water which is not in fact a material drawback except in certain portions of that region. It is doubtful if a region blessed with such reliable seasons is likely to make much use of underground water for irrigation, except for some specific crops such as possibly wine grapes. Western Australia has some immense potentialities in the north-west such as the Ord River, but with small opportunity to make use of these quite apart from being faced with unsolved problems in management. In the south-west of the State the problem of efficiency of water run-off from catchments is acute, as it is from these that less than 10 per cent. of the rainfall reaches the streams.

The Commission stresses the problems of irrigation, in particular the absolute necessity of adequate examination of all projects not only from the engineering but from the soil, the crop, and the economic points of view. In general their thesis is that stabilizing existing industries, particularly wool, meat and dairying, is likely to be a more profitable line of endeavour than increased production of dried fruit or growing new crops. There is not enough water for the maintenance of a large additional population in Australia. Beyond a conservative limit this must depend mainly on irrigation development. The good rainfall areas are still capable of some development controlled principally by economic considerations, but few of the unexploited areas of southern Australia offer good opportunities for intensive use.

Sub-artesian water supplies may be turned to profitable account where salinity is not unduly high. The Commission proposes that a proper scientific study of the question should be made by exploratory borings in appropriate places selected by geologists. The collation of boring logs and analysis of water quality would be of fundamental value in assisting or maintaining settlement in regions of uncertain water supply. The proper use of stored river water is for human consumption and food production, and the utmost use should be made of underground water for stock.

Technical Problems of Irrigation.

The Commission draws attention to the earlier recommendation in their third report for the setting up of a land utilization council in each State to control the policy of development. It is inferred that the proper body to manage the catchments of dams is the water supply authority as divided control is so liable to lead to exploitation and subsequent erosion, with the resultant loss of profit from the land and siltation of reservoirs. The efficiency of catchments in delivering water has been referred to in this connexion. Power generation and irrigation storage are opposites in requirements, the one involving regulated flow and the other storage against periodic needs. In passing, the Tennessee Valley in the United States, which is so widely and mistakenly used as a parallel case with the Murray Valley, was used for both purposes by duplicating the dams, but this is a luxury not possible financially or from the water aspect even on our main rivers.

The distribution of water to farms has always been a thorny question, involving the advisability of using lined or unlined channels. Lining of channels or use of pipes is expensive and not, of course, the perfect, enduring answer to seepage losses, but every effort must be made to save water even if, as the Commission points out, it becomes financially burdensome to do so. They emphasize the need for water measurement on the farm and payment for water used. They do not go so far as

some realists who suggest an ascending scale for water charges beyond a fixed maximum requirement for the particular crop or land use. All this leads up to the matter of correct water use on the farm, which is tied to the twin dangers of water-logging and salinity. The setting up of well equipped and staffed irrigation research stations in appropriate centres is the logical method of securing data on which to base any regulation of water supplies, and enable educational campaigns to be carried out soundly by extension authorities. Proper irrigation, which is the addition of approximately the right amount at the right time and by the right method, is still far from being realized on many irrigation settlements. In particular, the establishment of new irrigation areas in northern Australia involves probably a different management procedure and much that is already known by experience and research in southern areas may require drastic amendment. Cooperative State and Commonwealth investigation of such problems is a sound move.

Financial and Political Aspects of Irrigation.

These are discussed in a well-reasoned statement from the point of view of the landholders and the community. The rights of existing landholders to irrigation benefits on newly constituted areas without receiving an unearned increment from speculative price fluctuations of land is laid down firmly as well as the desirability of government control of water supplies from rivers to riparian owners. The latter feature is already embodied in the Victorian Water Act of 1905, since copied by most other States. The key to sound development lies in the determination of the uses to which irrigation water shall be put, and while in principle this should be brought about with the least interference with a property holder's right to produce a chosen crop, there must be some enforcement of regulations to prevent heavy over-production of commodities such as dried fruit or rice, which in the past have been controlled by the industry or the State.

Land Drainage.

Drainage is envisaged as a parallel case to irrigation. The Commission has concluded that there are considerable areas within existing irrigation areas as well as under better rainfall conditions which would benefit greatly from drainage either by surface channels or underground tile systems. The prime case quoted is the Mildura settlement, which was tile drained with great success during the depression years of the thirties. Other areas are in process of being similarly treated. The reclamation of small swamp areas in several States has also emphasized the benefits possible to production. Special mention is made of the south-east of South Australia, where drainage of 400,000 acres has been under review since 1923 and delayed partly by high costs and partly by opposition of landholders. Actually, although this point is not made clear in the report, this area, in many people's opinion, has not yet been studied as completely as necessary to determine the minimum drainage requirements. It has to be clearly recognized that with development to high producing pastures, minimum drainage is likely to be the optimum both for cost and to prevent overdrainage, which may be equally as serious a defect as underdrainage. A good deal of further examination is required before the best scheme can be confidently put forward. Opposition of landholders must eventually give way, although it is suggested by the Commission that the State should deal with this area exactly as an irrigation scheme by acquisition and subdivision into suitable sized units. They point out that as irrigation headworks are regarded as a charge on the State without necessary repayment by settlers, so also should comprehensive land drainage works be a State investment.

Certain Special Irrigation and Water Supply Problems.

The Commission's report traverses the available data on four water supply schemes proposed by various bodies as worthy of development. None are in concrete form as far as the use of the water is concerned, and at least one is nebulous.

(*a*) *Dr. Bradfield's Scheme.*

The Bradfield scheme, on the available facts, still remains a vague generality. The main basis on the engineering side is given in a statement by Mr. H. P. Moss analysing the possibilities of the transference of water according to known levels, which are scanty, and the storage heights of proposed reservoirs. In brief, there is tentative evidence of a fall in the level of the country such that with suitable and expensive construction water could probably be carried from the Tully River in the north to the Thompson River in the south and thence into Cooper's Creek. The data is inadequate for a positive statement and costing is impossible even in the roundest of round figures. Those estimated by Dr. Bradfield are merely shots in the dark, apart from being pre-war estimates, and in any case are so high (£80 million) that full examination of the potential water use is an essential prerequisite. The storage capacities based on catchment area and rainfall are no more than guesses, and according to Mr. Moss are very much less than Dr. Bradfield's figures. It would seem that the possible acreages for development would be, relatively speaking, moderate for such a scheme, and whatever the use, whether for stabilization of the stock industry or introduction of new crops, would appear to be on an insecure economic foundation. The Commission's hopeful conclusion is that by the time all necessary investigations of the engineering, soil and agronomic aspects are complete, the future economic position of primary production in Australia in relation to world supplies may be clearer and enable a decision to be made, always assuming the scheme is practicable. Dr. Bradfield's assumption of the improvement of climate following the installation of his scheme is dismissed on the findings of an expert committee of meteorologists who decided that the idea had no scientific basis.

(*b*) *Ord River Scheme.*

The Commission takes a favourable view of the possibilities of using the Ord River valley for irrigation development. As far as engineering investigations have gone the dam seems feasible for a storage of two million acre-feet, but at what cost in submergence of good country is not stated. The future problem is where and how should the water be used, but initially a clear opinion is needed on two other matters—first, as to the exact location of the dam site with minimum loss of grazing land, and second, as to the siltation danger which is very real through erosion on the watershed, an erosion for which control measures are at least difficult if not impracticable to apply. The investigation of the soil and agronomic factors will determine where and how the water should be used. The report is emphatic that if anything is to be done successfully the Research Station now in its infancy must be fully equipped and staffed with ample funds for experimental work in crop and water management. The existing station operated jointly by the W.A. Department of Agriculture and C.S.I.R. is not yet on a sound basis for such investigations. The Commission might have rendered a service by emphasizing, even more than it has, the difficulties of staffing and continuing work at these isolated stations. It may be added that the soil classification and irrigability is dealt with as fully as the data permit in a report put out by the W.A. Government in 1944 on Soil Surveys, Kimberley Division, Western Australia, and written by G. H. Burvill.

(*c*) *The Snowy River Proposals.*

The current investigation of the relative merits of the diversion of the Snowy to the Murray or Murrumbidgee Rivers aims to solve politically at any rate the problem of the best use of this, at present, wasted water supply. The four proposals—diversion to Murrumbidgee River, diversion to Murray River, part diversion to Murrumbidgee River, part to Sydney water supply, and solely for hydro-electric purposes—are set out clearly. In the broad view it is a matter of decision as to how the water shall be used as both the Murray and Murrumbidgee valleys command ample good land for intensive development and it seems generally agreed that

hydro-electric requirements and city water supplies are secondary to irrigation. The type of production may decide eventually the destination of the Snowy River waters.

(*d*) *Great Artesian Basin.*

The flows from bores and the durability of supply have been the cause of concern to State Governments and have been investigated by geologists of both Queensland and New South Wales, where the authorities are alive to the failing supply. Northern New South Wales bores have slackened by the pull of Queensland bores, due to the northward dip of the water-bearing basin. It is an obvious conclusion that the bores must be regulated and the water used with discretion. The Commission recommends the wise control of this resource by the States concerned as to flow-rates, distribution systems by lined channel or pipes to minimize seepage losses and the better supervision of new bores. The artesian supply is a national resource which while it may be controlled separately by States should be the subject of cooperative investigation by the Commonwealth as well. It is estimated that 20 per cent. of Australia's sheep are dependent wholly or in part on artesian water, and this is its main use as the salinity is commonly too great for any long-term irrigation usage.

The Eighth Report of the Rural Reconstruction Commission deals with the national aspects of irrigation, drainage and water supplies as affecting production and rural economy. It is clear that water is a powerful controlling factor in markedly increasing production of specific kinds, in making intensive use of hot regions with less than 20 inches of rainfall and in helping to stabilize the sheep industry in country liable to periodic droughts. Australia could not on rainfall alone, even assuming higher farming efficiency, cope with a much higher population. The statement of irrigation and drainage problems and the measures for overcoming them have been traversed in the report clearly and the conclusions are those which in the main have been generally arrived at by scientific workers. The Commission does a very real service in lending the weight of its opinion and authority to the statement of the case and the action, political, financial, educational and in research, which may cope with the problems on old and new irrigation or reclaimed areas.

We have come to expect from the Commission the lucid assemblage of facts, logical argument and shrewd comment, all in clear, happy phrasing, and this report is a worthy member of the series.

J. K. Taylor.

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The Use of Insecticidal Aerosols on Agricultural Crops

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Insecticidal aerosols were first produced by spraying solutions of insecticides on to a hot surface. Later, a cold method was developed and applied to the dispersion of insecticides. The process is very simple. It is necessary only to release a solution of the insecticide in a suitable liquefied gas through a spray nozzle, and the aerosol, meaning a suspension of fine solid or liquid particles in air or gas, is formed by the rapid evaporation of the solvent in much the same way as when higher boiling solutions are sprayed on a hot surface. The heat of vapourization in this case is supplied from the atmosphere.

Low Boiling Solvents for Dispersing Insecticides.

Recent advances in the development of new refrigerants have made available several low-boiling solvents that are adaptable to the dispersion of insecticides. Dichlordifluoromethane (Freon-12) is the most satisfactory compound for the production of insecticidal aerosols by the liquid-gas method if these are to be used in the presence of man or animals, as it is non-toxic, non-inflammable, inert and odourless and has a suitable vapour pressure. Owing to the difficulty of obtaining sufficient supplies of it to meet war-time demand for aerosols containing pyrethrum and D.D.T. for anti-malarial measures, substitutes or diluents were sought.

Substitutes or Diluents for Freon-12.

The compounds tested as diluents for Freon were butane, propane, dimethyl ether, methyl chloride and methylene chloride, and the first four and also chlordifluoromethane (Freon-22), chlorfluoromethane (Freon-31) and a mixture of equal parts butane and propane were tested as substitutes. It was found that propane and a mixture of equal parts of propane and butane (which has about the same vapour pressure as Freon-12) were as effective as the Freon in producing a toxic aerosol, but butane was less so, presumably on account of its lower pressure. Propane is too inflammable to be used alone. Imported propane (at 1s. 6d. a lb.) and natural butane (at 3d.-6d. a lb.) are available in Australia and suggest that by their use agricultural aerosols may be produced in this country at a relatively low cost. Their toxicity to man is low, but they are not good solvents as liquids except for oily materials, and they are highly inflammable. However, they may be used to replace just over 20 per cent. of Freon-12 without making an inflammable mixture.

Ethyl fluoride and other halogenated compounds are being considered, and liquid carbon dioxide was used in the sparklet bombs developed in Britain during the war. Sulphur dioxide has been used to make aerosols of potassium iodide, but the application of this solvent to the production of insecticidal aerosols would be limited.

Dimethyl ether (b.p. —9·6° F.) is a good solvent for many organic insecticides, especially D.D.T. It is not toxic to animals at the concentrations used, but it is highly inflammable, and not more than 25 per cent. of Freon-12 can be safely replaced by it.

Methyl chloride, which at present has to be imported, approaches Freon-12 in suitability for aerosol production, except for its toxicity to man and animals. It is used exclusively for the production of agricultural aerosols, but unless it can be produced cheaply in this country, its use in practice will be uneconomic. It is excellent for use out of doors. It boils at —10·7° F., is a good solvent for nearly all organic insecticides, especially D.D.T., and is not inflammable at the concentration built up by an aerosol.

Methylene chloride is liquid at room temperature, is easily volatilized and can be substituted for up to one-third of the weight of Freon-12 without reducing the effectiveness of the aerosol. It is non-inflammable and only slightly toxic to animals, and is an excellent solvent for many organic insecticides, including D.D.T. and rotenone. It appears to be the most satisfactory practical diluent for Freon-12.

Carbon dioxide is inexpensive, but its boiling point is so low that it is difficult to handle with ordinary equipment. Moreover, it is a poor solvent for insecticides. The vapour pressure can be reduced by admixture of acetone, which has useful solvent properties. A mixture of one part of liquid carbon dioxide and five parts of acetone by weight gives a pressure of about 300 lb./sq. in., and produces an inflammable spray.

Nitrous oxide has too high a pressure to be practical unless it is mixed with some low pressure solvent. It is non-inflammable but will support combustion.

Aerosols for the Distribution of D.D.T.

There is no doubt that aerosols are a most effective means of distributing D.D.T. for the control of crop pests. A satisfactory formula for this purpose contains

Formula No. 1.

D.D.T.	5%
Cyclohexanone	5%
Lubricating oil S.A.E. 10	5%
Acetone	35%
Methyl chloride	50%

In the United States this has proved effective for insects of peas, beans, potatoes, onions and a variety of other crops. 10 lb. per acre gave a 90 per cent. kill of pea aphids. This produces an aerosol of particles having a wide size range (with a mean diameter of about 20μ), which is valuable in that it results in a drift of 15-25 feet under normal operating conditions. For greenhouse treatment the methyl chloride is replaced by Freon-12.

A formula omitting cyclohexanone, which is not commercially available in Australia, and which the writer has found satisfactory, contains —

Formula No. 2.

D.D.T.	5%
Acetone	35%
Freon or methyl chloride	50%
Aromatic petroleum solvent 202	10%

There is reason to believe that A.P.S. 202 or similar type of oil will soon be procurable.

Equipment Required.

Little equipment is needed for the preparation of insecticidal aerosols. The pressure of the solvent is used for spraying, the mixture being emitted from the container through a nozzle like those commonly used on oil burners. If the tank or "bomb" is to be used in an upright position, it must have a liquid delivery tube extending to the bottom, since the solution and not the gas must be sprayed. An oil-burner nozzle designed to deliver 2 gal. per hour at 100 lb. per square inch has been found suitable. It is usually desirable to insert a filter to prevent clogging of the nozzle or nozzles. The orifice is the smallest constriction, so that no expansion takes place until the solution is sprayed into the atmosphere.

For applying aerosols to crops the writer, following overseas experiments, has used an apparatus consisting of a boom of light steel tubing supporting oil burner nozzles, located in pairs and fed through thin copper tubing. The boom is mounted on a frame which is covered with canvas and fitted with bicycle wheels and a draw-bar for pulling by hand. A rack at the centre of the machine supports the aerosol container. The filter is fitted in the main feed line. The bicycle wheels are attached in a manner that allows raising and lowering the boom for various crops, and adjustable for width of row. An aerosol container of 5 lb. capacity, or sufficient for half an acre, is used.

The machine is drawn by hand through the crop at 2·5 to 3 miles per hour with a twelve-foot apron or curtain attached to the back of the machine.

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The Pastoral and Agricultural Growing Season in North-Eastern Australia*

By

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The Plant Introduction Section of the Division of Plant Industry, C.S.I.R., in its work in Queensland, has suffered from the lack of a detailed agro-climatological survey of the State. A comprehensive survey would require lengthy investigations of climatic and other factors, but a preliminary approach is made in this paper, with emphasis on the aspects of particular importance for plant introduction.

The rainfall in most parts of Queensland is extremely variable, and prolonged dry spells are often a feature of the environment. Excessive precipitation from time to time can give the monthly mean a high value which may be misleading if it is used to determine critical climatic indices, even in those cases where rainfall records have been maintained for two-thirds of a century. This point may be illustrated by an example. Prescott,[2] in surveying the climate of tropical Australia, has used the figure of five as a critical value for the ratio monthly precipitation/saturation deficit. When this ratio is calculated for Townsville on values for the month of November, a figure slightly in excess of five is obtained, but an analysis of the data shows that in only twenty-two out of sixty-seven years has a ratio of five or more been recorded. Thus, in most years the growing season at Townsville would commence later than November.

When studying a locality from a plant introduction viewpoint, a question of primary importance must be " When can plant growth commence, and what is its probable duration ? " To provide this information a quantitative expression of the environment that provides for dry periods and yet is unaffected by excessive precipitations is required. The approach described in the next section is an attempt to determine the approximate length of agricultural and pastoral seasons in north-eastern Australia from a study of the percentage occurrence of wet months as determined by a climatic index.

Selection of Climatic Index.

It was realized at the outset that the recasting of locality rainfall records for individual years in a form to separate wet months from dry months was required. To this end, two climatic indices were compared, viz. :

(1) The Meyer ratio of precipitation to saturation deficiency at the level of five as developed by Prescott,[2] i.e. P/SD=5, and

(2) The Aridity Index of one as developed by Andrews and Maze[1] from the formula devised by de Martonne and expressed as P/T+10 (precipitation in millimetres, temperature in degrees centigrade), i.e. P/T+10=1.

Both of these equations can be solved for precipitation at any locality by making use of mean temperature and humidity records. Thus, it is possible to determine for a locality the rainfall required to produce the above selected values of each index for every calendar month of the year ; e.g., at Townsville 147 points of rain would be needed in January to produce an Aridity Index of unity, as against 116 points in July.

* The substance of a paper presented before Section K of the Australian and New Zealand Association for the Advancement of Science at Adelaide in August, 1946.

TABLE I.

Portion of Table showing Occurrence of "Wet" and "Dry" Months at Townsville

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Critical rainfall	1·47	1·47	1·44	1·37	1·28	1·12	1·16	1·09	1·28	1·37	1·42	1·47
1871	W	W	W	D	D	D	D	D	W	W	D	W
1872	W	W	W	D	D	D	D	D	D	D	W	W
1873	W	W	W	W	D	W	D	D	D	D	D	W
1937	W	W	W	D	D	D	D	D	D	D	W	D
Total D ..	4	6	11	31	46	46	57	56	54	43	43	20
Total W ..	63	61	56	36	21	21	10	11	13	24	24	47
Percentage W..	94·0	91·0	83·6	53·7	31·3	31·3	14·9	16·4	19·4	35·9	35·9	70·1

By determining these limiting monthly rainfalls for each calendar month at a particular locality (row 1, Table 1), one can proceed to recast the rainfall records of that station in the form of a table of "wet" and "dry" months, based on whether the recorded monthly rainfall is greater or less than the limiting figure (Table 1). For each column of the table the number of "wet" months recorded can be totalled. This figure can then be expressed as a percentage and graphed.

The graphs for three stations adjacent to the Tropic of Capricorn are presented to enable comparison of the two climatic indices. Longreach, an inland station, gives a Meyer Ratio graph at a lower level than the Aridity Index graph (Fig. 1); Emerald, a sub-coastal station, reveals a closer fit (Fig. 2); whilst Rockhampton, on the coast, shows close agreement (Fig. 3). Actually, all the coastal stations (having high humidities) give sets of curves that are in close agreement, whilst inland stations of low humidity show greater deviations due to a higher limiting rainfall for any month under the Meyer Ratio of five than under the Aridity Index of one.

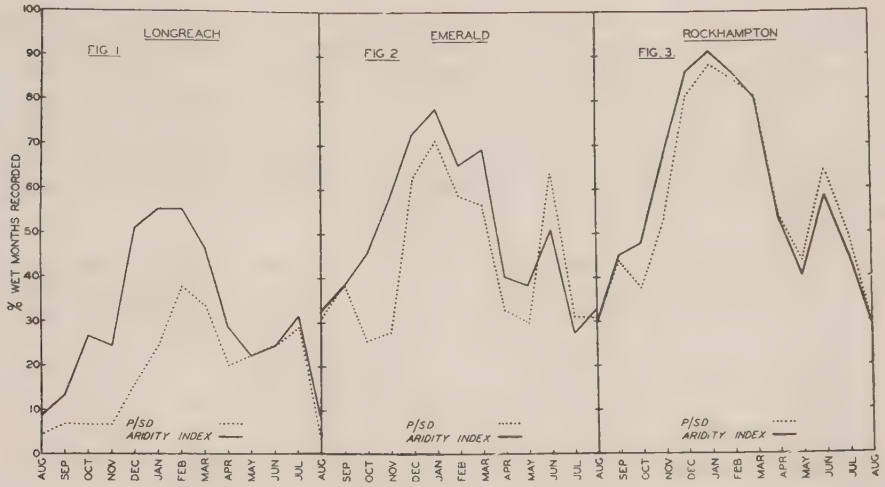
For the purpose of this survey the Aridity Index was selected. When compared with recorded pasture yields from experimental projects at the "Fitzroyvale" Plant Introduction Station, the monthly Aridity Index of one gave a reasonably satisfactory definition of months that permitted growth. Most of the exceptions arose from the fact that many species show marked periodicity of growth, not closely correlated with climatic factors.

Moreover, the Aridity Index can be more generally applied, both within the country and in the study of world homoclimes, as temperature records are more often available than humidity records and can be readily interpolated.

Calculation of Length of Pastoral and Agricultural Growing Seasons.

Tables of "wet" and "dry" months were constructed for 205 Queensland stations, using published and unpublished data of the Commonwealth Meteorological Bureau.[5]

To define the limits of the "wet season" from these tables of "wet" and "dry" months (*cf.* Table 1), it was arbitrarily decided that a calendar month which was "wet" in more than 50 per cent. of years was within the "wet season". Thus by this criterion the duration of the "wet season" at Townsville was found to be



Figures 1, 2 and 3.
Frequency of wet months for three Queensland stations as determined by the Meyer Ratio and the Aridity Index.

five months (December-April). It was found that groups of consecutive months constituted the " wet season " in the northern two-thirds of Queensland. In the southern third of the State, the occurrence of some " dry " months in autumn at times separated a long wet sequence during summer from a short wet sequence during part of winter. To enable a comparison with the north of the State, only the continuous wet sequence occurring during summer was used. Attention is paid to these winter " wet periods " when discussing the various zones.

Having thus defined the duration of the " wet season ", the mean number of " wet " months per season (within the defined " wet season ") was then calculated for each selected station—e.g., the mean number of " wet " months recorded during the five-months period December-April at Townsville was 3·9 months. Subsequently these figures were plotted on a map and the isolines drawn (Fig. 4). The map presents an assessment of the length of the pastoral growing season in north-east Australia.

In determining the suitability of a region for permanent agriculture, it is desirable to use a higher level of expectancy in the assessment of the growing season. To show this, a second map was prepared, taking the 70 per cent. level as a base and following the same procedure of preparation (Fig. 5). The map represents an assessment of the length of the agricultural growing season in north-east Australia, on the basis that permanent cropping systems would require a high order of reliability in the recurrence of the growing season. As the level of expectancy recedes from 70 per cent. to 50 per cent., areas group themselves into zones of pastoral rather than agricultural growing length. Comparison of the two maps will indicate the comparative features of any locality.

Discussion of Zones of Seasonal Length.

It is proposed to discuss in detail the map in Fig. 5 (Agricultural Season). A range of seasonal lengths from two to ten months is shown, some of the intermediate isolines having been omitted because of the small scale of the map.

(*a*) *Under Two Months Zone.* Having such a short and indeterminate summer season, this zone has no permanent agriculture based on natural rainfall. It is devoted to grazing and carries a great proportion of Queensland's sheep population.

It includes Savannah and Mitchell Grass Downs, and the shortening of the season westwards is accompanied by development of semi-desert and shrub steppe.

(*b*) *Two-Three Months Zone.* This is a very narrow zone in the north with a long dry season. In the extreme south the short summer season is utilized for the marginal production of grain sorghums on selected soils. Summer fallows provide reserves of moisture and there are two months during the winter which are likely to be wet in 60 per cent. of seasons. This makes for successful wheat cropping (ripening being assured by the dry spring), e.g. at Miles.

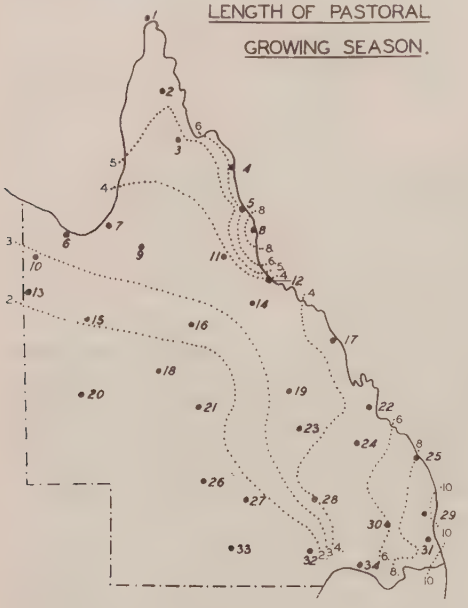


Figure 4.
Length of Pastoral Growing Season (in months).

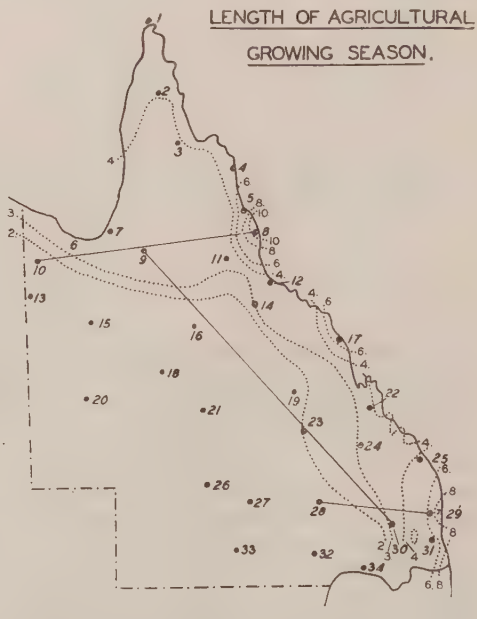


Figure 5.
Length of Agricultural Growing Season (in months), with transects through selected stations.

TABLE 2.

Index to Localities shown on Maps 1 *and* 2.

(1) Thursday Island.	(8) Innisfail.	(15) Cloncurry.	(22) Rockhampton.	(29) Crohamhurst.
(2) Mein.	(9) Croydon.	(16) Hughenden.	(23) Springsure.	(30) Dalby.
(3) Musgrave.	(10) Lawn Hill.	(17) Mackay.	(24) Banana.	(31) Brisbane.
(4) Cooktown.	(11) Valley of Lagoons.	(18) Winton.	(25) Bundaberg.	(32) St. George.
(5) Cairns.	(12) Townsville.	(19) Clermont.	(26) Adavale.	(33) Cunnamulla.
(6) Burketown.	(13) Camooweal.	(20) Boulia.	(27) Charleville.	(34) Goondiwindi.
(7) Normantown.	(14) Charters Towers.	(21) Longreach.	(28) Roma.	

(*c*) *Three-Four Months Zone.* This is a large zone in the north covering much of the Gulf and Peninsula areas, with mean annual rainfalls varying from 25 in. across its southern gulf portions to 50 in. in its northern peninsula portions. This short summer season has a high reliability and is followed by a long dry season of equally high reliability.

The zone narrows, like an hour glass, as it reaches the east coast to continue southwards across the lower and middle Burdekin River basin. Agriculture in this coastal area is largely conducted under irrigation. The summer growing season is slightly less reliable than that of the gulf and peninsula areas. At Bowen the long dry season has permitted the development of a salt industry based on the natural evaporation of sea water. The mean annual rainfall ranges from near 50 in. on parts of the coast down to 20 in. in the sub-coastal portions.

South of the Tropic of Capricorn the reliability of summer rainfall is maintained and the reliability of winter rainfall increases progressively towards the south, finally allowing commercial wheat production on suitable soils—e.g. at Dalby. (See Fig. 8.)

(*d*) *Four-Five Months Zone.* In the north this zone covers the upper portion of the peninsula. Here the mean annual rainfall is high—ranging from almost 70 in. at Thursday Island to 50 in. at Moreton, and the reliability of the wet season approaches 100 per cent.

The zone continues southwards across the western Atherton Tableland. It is represented again in the sub-coastal country behind the Proserpine-Mackay coastal strip, where the mean annual rainfall varies from 55 to 70 inches.

The central coastal sections of this zone, as represented by the districts around Rockhampton, Gladstone and Miriam Vale, are essentially beef cattle areas, with limited agriculture and dairying on the better class soils.

The southern area of this zone has been subdivided by the $4\frac{1}{2}$ months isoline. The 4-$4\frac{1}{2}$ months portion combines beef cattle and dairying with a summer agriculture where edaphic factors are suitable—Kingaroy, the centre of the peanut industry, being an example. The $4\frac{1}{2}$-5 months portion supports a mixed agriculture of maize, lucerne, pumpkin, potatoes and green forage besides dairying, whilst the ever-present beef cattle industry is represented on the country which is less useful for agriculture.

(*e*) *Five-Six Months Zone.* This is a narrow corridor in the north and embraces part of the Atherton Tableland. It reappears again as a narrow corridor in the Mackay sub-coastal country, and on the coast east of Rockhampton, from Emu Park northwards, where fruit growing (chiefly banana, pineapple and citrus) is developed.

South of the Tropic it enters the coast north of Maryborough in a citrus area, proceeds south as a narrow belt, to widen across the valleys of southern Queensland.

(*f*) *Six-Seven Months Zone.* In the north the summer growing season has a high level of reliability with a mean annual rainfall of 80 in. or over. In this area the sugar-cane industry is developed at Port Douglas, Cairns and Ingham, while at Cardwell, where topography and edaphic factors are favourable, fruit is grown.

In the Proserpine-Mackay-Sarina area the reliability of the long growing period is nearly as high and the mean annual rainfall only slightly lower at 65-70 in. This is an important sugar-cane belt.

South of the Tropic the zone enters the coastal country near Maryborough, where sugar cane is grown. Further to the south, in sub-coastal country, the zone is associated with dairying and mixed agriculture.

(*g*) *Eight-Nine Months and Nine-Ten Months Zones.* In the north these zones are devoted to cane on the coastal approaches, and dairying on the wet tableland portion. In the south they support dairying, agriculture and sub-tropical fruit growing.

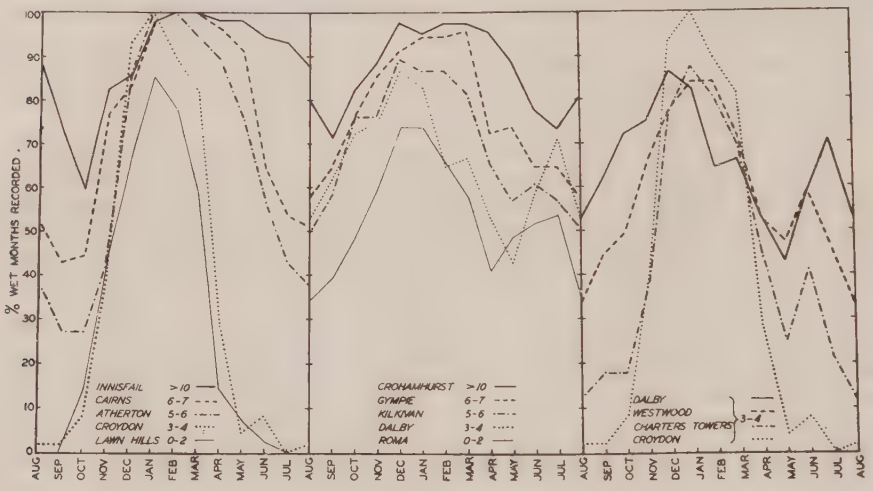
(*h*) *Ten Months Season.* In the north around Innisfail sugar cane is the major industry, with dairying for local needs. Mean annual rainfall is approximately 150 in. in this area. In the south, the equally long growing season has a lower mean annual rainfall (74 in. at Crohamhurst), and is useful tableland dairying country.

Discussion of Transects

Graphs of representative stations on the transects in Fig. 5 are shown in Figs. 6, 7 and 8, covering a range of zones. The transects follow three directions, viz.: west-east in the tropical portion of Queensland, west-east in the extratropical portion, and north-south linking the first two.

West-East Tropical Transect (Fig. 6). The graphs in this figure cover a transect from Lawn Hills (with a summer growing season of under two months) across the Gulf country to the coastal zone at Innisfail (with a growing season of slightly more

than 10 months). The reliability of the summer growing season is high in all zones in the north of Queensland, and this is well shown by several of the graphs recording 100 per cent. levels of wet months in mid summer. The Gulf country, represented by the graphs of Lawn Hills and Croydon, has a well defined dry season (April to November). The eastern coastal plains and adjacent tablelands, as represented by the graphs for Innisfail, Cairns and Atherton show less definition of the dry season, due to orographical effects.[4] At Atherton 27 per cent. of the September months are " wet ", at Cairns 43 per cent., but the dry season is an ever-present hazard. In all cases the " wet season " develops sharply.



Figures 6, 7 and 8.
Wet Month Frequencies for Stations on Transects shown on Figure 5.

West-East Extratropical Transect (Fig. 7). A selection of stations from Roma (under two months summer agricultural season) to Crohamhurst (with more than 10 months season) has been graphed.

Compared with data in Fig. 6 they show a more gradual advance to the summer levels of reliability as a consequence of a higher reliability of " wet " winter months. These winter rains, when preceded by a summer fallow, are sufficiently reliable on the Darling Downs to enable wheat production. The shape of the graph for Dalby is fairly typical of the wheat areas : some districts, like Pittsworth, being even more reliable the year round.

The native perennial pasture species of the south, as in the north, show a summer periodicity of growth. Where permitted to do so by overgrazing, or by removal of the previous summer season's growth, winter annuals develop in the pasture within the definite limits imposed by winter rain and temperature effects. As most of the precipitation falls in summer, the quantity of winter feed produced is relatively small.

That a wide compass of summer cropping is permitted by the gradually increasing seasonal length is well shown by these graphs. With lengthening of the season, dairying becomes more important.

North-South Transect (Fig. 8). This transect covers stations in the 3-4 months zone of agricultural growing season, linking Croydon on the Tropical West-East Transect (Fig. 6) with Dalby on the Extratropical West-East Transect (Fig. 7). The seasonal length maintains a 70 per cent. reliability as we proceed southwards, and there is a gradually increasing expectancy of June-July rains, which finally

Figures 9, 10, 11 *and* 12.
The upper maps (Figures 9 and 10) show the distribution of sheep and dairying in relation to the length of the pastoral growing season. The lower maps show the areas of sugar cane and maize cultivation in relation to the length of the agricultural growing season.

reaches a level permitting wheat culture when preceded by a summer fallow (as at Dalby). As winter reliability improves southwards from the Central Districts, the seeding of winter cereals for dry season grazing is, with antecedent fallow, more favoured in the rotations practised.

The general trends from north to south as shown in this figure are typical of the other zones of seasonal length—a very slight reduction in summer expectancy and a gradual rise in reliability of the winter wet period.

Pastoral and Agricultural Correlations.

The distributions of the major primary industries in relation to the calculated seasonal lengths are briefly discussed and illustrated by maps, the isolines of seasonal length being imposed upon the geographical distribution of production.

Sheep. The distribution of sheep in Queensland is shown in Fig. 9. The major portion of the State's flock is located within the three months pastoral growing season. In central Queensland an easterly extension into the $3\frac{1}{2}$ months pastoral zone occurs, whilst in south-eastern Queensland there is an extension across valuable pasture of greater seasonal length (due to the earlier summer rains) to the mixed farming areas of the eastern Darling Downs. Parasites limit the distribution of sheep in some parts of the State.

Dairying. Dairying (Fig. 10) has a limit marked by the $4\frac{1}{2}$-5 months pastoral growing season. The westward tongue extending into the Roma area is associated with the railway transport system, but accounts for less than 1 per cent. of the State's production. In the shorter seasonal areas dairying is usually a summer enterprise and complementary to beef production.

Cattle. The distribution of cattle (beef and dairy herds combined) is not mapped, as it is widespread throughout the State. The most favoured zones for beef cattle are those beyond the limits of dairying and agriculture, or in the mountainous and second-class country.

Wheat. The wheat areas, though based on a summer fallow, show no direct relationship to the summer " wet period ", but are roughly limited by a mean " wet month " expectancy at the 60 per cent. level for the May-July period. Edaphic factors also are contributory, the major production areas being on the Darling Downs.

Sugar Cane. Sugar cane (Fig. 11) is grown in northern Queensland, where the agricultural season is of six months or longer duration. The area in the Burdekin River delta, in the 3-4 months agricultural seasonal length, is dependent on supplementary irrigation during the dry season. In the Bundaberg-Childers area the agricultural season is slightly shorter, but here edaphic factors, supplementary irrigation, and winter rain contribute to productivity.

Maize. Although not apparent from the map, the bulk of this crop is produced (Fig. 12) with a seasonal length of $4\frac{1}{2}$ months or more, the acreage beyond this isoline being less than 5 per cent. of the State's total. The absence of a maritime distribution is noteworthy, being an example of edaphic control.

Conclusions.

The Peninsula and Gulf portions of the State with high " wet month " expectancy, accompanied by rainfall at useful levels, appear to have production possibilities should soil surveys indicate suitable areas. As this country is frost free, the desirability of seeking summer growing supplementary grazing crops and pasture species suitable for reserve dry season grazing (i.e. " self-haying ") is indicated.

The Central Districts of the State, with a dominantly summer rainfall accompanied by low winter rainfall at a low level of expectancy and a frost risk, require summer growing cash or fodder crops for the agricultural season. Relatively drought-enduring crops such as grain sorghums should be attractive in the more favoured areas for use in stock fattening projects, or as constituents of supplementary dry season feed in the pastoral zones of shorter seasonal length. In zones where the agricultural season is shorter the thorough testing of the coarse cereals of Asiatic and

African agriculture (including millets) that lend themselves to mechanical harvesting, should be well warranted. The pastures need summer growing legumes that can persist by virtue of autumn seed setting (before onset of frost) or perennate by means of frost resistant root stocks. Above all, such legumes must provide reserves of palatable nutritious dry season grazing even in the frosted condition.

The pasture legume requirements in most of the south-east of the State would appear to be similar to those of the central districts except that, in areas with reliable winter rain at a useful level, some constituent species of the pasture should have a capacity for late winter or early spring growth. Such plants might be perennial legumes with a winter-spring periodicity of growth, and be complementary to summer-growing species.

Summary.

A method of calculating the length of pastoral and agricultural growing season, using the monthly Aridity Index of one, is described.

Two maps, delineating the zones of pastoral and agricultural seasonal length in north-eastern Australia, are developed.

The seasonal distribution of wet months in each zone is discussed, and the zones correlated with the geographical distribution of the major primary industries.

Conclusions are drawn relative to plant introduction needs in these zones.

The author desires to express his thanks to Mr. Colin Clark, Queensland State Government Statistician, who made available mapped details of primary production, and permitted the use of the sheep and cattle distribution maps appearing in the 1945 Year Book.[3]

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The Technique of Sugar-Cane Breeding

By

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The growing of sugar cane is confined to the central and northern portion of the eastern seaboard of Australia, with the most important part in tropical Queensland. It is somewhat isolated from commoner and more widespread crops such as wheat, fruits and vines, and only rarely are workers in crops of temperate areas brought into direct contact with those interested in sugar-cane culture. The literature on the various aspects of cane culture (and also of sugar manufacture) is rather specialized and not widely circulated outside the sugar-producing areas, and it was thought that geneticists and agriculturalists in general would be interested in a brief description of methods used in Queensland to produce new varieties of sugar-cane, with particular reference to unusual features of the actual crossing technique.

The methods of obtaining new canes are basically the same as for any other crop, viz. :

(1) the introduction from other countries of ready-made commercial varieties, and
(2) the raising of new varieties from seed.

The first-named method scarcely deserves mention in an article on breeding except to say that sugar cane appears to be one of the few crops of which many commercial varieties have been obtained direct from uncivilized countries within recent times. In New Guinea and the surrounding islands many types of canes are found, either wild or crudely cultivated by the natives, and several expeditions have been equipped to search for and bring back promising canes. Among the earliest of these expeditions was that led by the late Mr. Henry Tryon, then Government Entomologist in Queensland. In 1896 he returned with a number of canes, one of which, identified as " N.G.15 " or " Badila ", became the most popular cane in Queensland and even to this day produces nearly one-third of the total yield of the State and approximately one-half of the yield from the northern areas. Several other canes brought directly from New Guinea have also proved commercial successes but all are " noble " canes, i.e., they are varieties belonging to the species *Saccharum officinarum* and have not the hardiness of the true wild canes. With decreasing soil fertility and increasing demands being made on the failing soil, these " noble " canes are being displaced in all parts of the world by hybrids containing some " wild blood ". Recent collectors in the New Guinea group, therefore, have been more interested in procuring wild canes for hybridization work than in collecting the cultivated " chewing canes " of the natives. The introduction of commercial canes from other countries is a well-established practice in the sugar world and for many years canes went freely from one country to another, leaving, as one would expect, a legacy of disease for the more enthusiastic importers. Within recent years elaborate quarantine facilities have been established and usually the importation of canes into each country is in the hands of a single authority.

The Raising of New Varieties from Seed.

Although sugar cane has been cultivated for many hundreds of years, not until the middle of the last century was it realized that cane would set seed. In 1869-70 the first systematic attempts were made to raise canes from seed. Australian workers were amongst the pioneers in this work ; cane breeding having been carried out in Queensland more or less continuously since 1890. At present, there are two breeding stations in this State, one conducted by this Bureau near Cairns and the other by the Colonial Sugar Refining Company Ltd. near Ingham.

It is not surprising that the ability of cane to set seed escaped notice for such a long time. For one thing, cane is essentially a warm weather crop and, with rare exceptions, will set seed only within the tropics. The surge of scientific enquiry during the ninteeenth century took place in the temperate regions of the world, and the tropics were comparatively untouched ; even in this enlightened decade there is a different attitude towards tropical research stations than to those in more temperate latitudes.

Figure 1.
Inflorescence of sugar cane.

The inflorescence of sugar cane is an open panicle (Fig. 1), and it is gigantic in comparison with nearly all other grasses. There may be over 2,000 flowers in a panicle of cane and the heads of some varieties are four feet from the base to the tip. Borne on well-grown sticks, the panicles may be up to 18 feet from the ground. It is easy to understand why the cane breeder does not carry a stool, or some other seat, as does the wheat breeder ! It usually takes eight to twelve days for all flowers to open in any one head, and during that period in the fertile varieties some pollen is released each day. Even though the anthers are much smaller than, for instance, in sorghum, there are so many of them that small pollen-clouds can usually be seen under suitable conditions. The clouds may be released as the dew dries from the flowers by smartly tapping the stem.

Selection of Female and Male Parents.

Owing to the small size and extreme delicacy of the flowers, emasculation is usually out of the question, but fortunately some varieties do not produce viable pollen and others, while producing pollen fertile for other canes, are self-sterile. Both these types can be used as female parents. In some pollen-fertile varieties normally useful as male parents, there are often variations in pollen viability, depending on the season, state of the crop, etc. Viability of pollen grains can be

tested by germination on suitable stigmata but for routine tests the most useful method is a microscopic study of the grains after staining with iodine. Solid, spherical grains containing starch are usually fertile : unstained, shrunken grains, sterile. A rough approximation of the percentage of fertile grains indicates whether the cane can be used as a female or would be a success as a male. The self-sterile types can be found only by experience, although there is no doubt that a careful study of the ripening and fertilizing mechanism would explain the reason.

Technique of Crossing.

In setting up a cross the usual practice is to cut off the stick bearing the arrow so as to leave a total length of stick plus arrow of about twelve feet. The arrowed sticks are transported to the crossing stands, which are usually set in light forest or some other cover affording protection from high winds, and the desired combinations made. The female arrows, usually four for each cross, with a varying number of males depending on pollen production, size of arrows, etc., are then stood in small drums containing two gallons of a solution of 0·01 per cent. sulphur dioxide and 0·01 per cent. phosphoric acid. The sulphur dioxide is obtained direct from a cylinder of the gas and the phosphoric acid from dilution of the 1·75 S.G. acid. The females must, of course, be protected from contamination by unwanted pollen. This can be done either by setting up the crosses at sufficient intervals through the forest (one chain appears to be a suitable distance) or by the use of " lanterns " (Fig. 2). These

Figure 2
Crossing stands with " lanterns ".

are three feet square in cross section and six feet deep and consist of a cotton voile covering over a wooden framework mounted on a stand so that the tops of the " lanterns " are about fourteen feet from the ground. Several " lanterns " may be mounted on the one stand, which makes for considerable economies in time and labour in comparison with dispersed stands.

Every second day the solution in the drums is renewed and at the same time an inch or so is cut off the bottom of the stick to expose a fresh surface for the absorption of the solution. Pollen is released on to the females by tapping the male stalks each

morning, and after about ten days, when pollination is complete, the females may be collected and the stands used for further crosses. The changing of solution and stick cutting continue until the seed is ripe, usually about thirty days after setting up the cross.

Handling Seed and Seedlings.

The ripe arrows are picked and dried for a few days in voile bags. The " fuzz " is then stripped from the stalks and main branches of the arrows and stored with calcium chloride in air-tight tins in a cold room. Seeds remain viable for up to two years under these conditions, but usually they are kept for only one year, since the chief object of storing is to insure against a very bad arrowing and to provide seed for sowing at an earlier date than would be possible from the current production.

The seeds of sugar cane are very small, an ounce contains about 100,000, so that they need carefully controlled conditions for germination and early growth. Without further treatment the " fuzz " from the tins is sown directly on to steam-sterilized flats and covered with either glass or waxed paper. In the warm atmosphere of the glasshouse the seeds germinate within 44 to 48 hours and after about four weeks are transferred to bottomless pots made from short lengths of four-inch down-pipe and grown in the open for a further six weeks. They are then ready for transfer to the field, where they are usually selected the following winter or early spring, i.e., about nine months later. By this time the seedlings have produced a quantity of cane comparing favourably with the production of commercial canes.

Sugar cane is, of course, heterozygous to a marked degree and fields of seedlings very obviously demonstrate this fact. The variation is, as in many other crops, both the despair and the hope of the plant breeder, but it is not intended to detail here the process of selection and testing which has to be laboriously followed over several years before a commercial cane is ready for the farmer's paddock.

Advantages of Using Crossing Stands.

It may be asked why it is necessary to cut the arrowing sticks of both parents in preference to leaving, say, the female parent growing in the field. The chief advantage of the method described above is that in the " crossing lanterns " or in light forest the chances of contamination are reduced when compared with that likely in an open cane field. Contamination in cane crossing work is a serious problem since the crosses have to be made over a period of several days and the size and height of the arrows do not make for easy handling or easy protection of the chosen arrows. Another advantage is that all crosses are brought to the one centre and, instead of being scattered through many fields over an area of several square miles, they are on a convenient site and can be easily supervised. Pollination and ripening can be closely watched and there is much less likelihood of loss through stock, accidental cutting or burning. Again, the required breeding canes may not arrow at the same time and in the same place, or arrows may appear in isolated localities not easy to reach. When it is possible to concentrate the arrows at the one place most of these difficulties disappear and many more crosses may be made with the same amount of time and labour.

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The Possibilities of the Plant Growth-Regulating Substances as Herbicides in Australia

By

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Great interest has been aroused in Australia by overseas reports of selective herbicidal properties exhibited by a group of chemicals known variously as " plant growth-regulating ", " growth-promoting " or " hormone-like " substances. These compounds are not plant poisons as commonly known, but possess certain stimulatory and inhibitory properties, and when applied in sufficiently high concentrations, may kill certain plants.

A large number of compounds have been tested overseas for their activity in promoting cell elongation.[4, 5] To date, the most promising have been the phenoxyacetic acid derivatives, 2-methyl 4-chlorophenoxyacetic acid, 2, 4-dichlorophenoxyacetic acid, and 2, 4, 5-trichlorophenoxyacetic acid. The first-named substance has been developed, chiefly, in England,[1, 4] and is marketed commercially in Australia as " Methoxone " (sodium 2-methyl, 4-chlorophenoxyacetate) both in the form of a 10 per cent. solution and a 1 per cent. dust. The two other compounds have been used mainly in the U.S.A.[2] and are known popularly as " 2, 4-D " and " T.C.P.", respectively. " T.C.P." is not marketed in Australia yet, but 2, 4-D can be bought in the form of the water-soluble sodium salt and is marketed under a variety of trade names.*

The phenoxyacetic acid derivatives have in general been more effective on dicotyledonous plants than on monocotyledons, such as cereals and grasses.[2, 4] This selectivity has enhanced their potentialities as herbicides for controlling weeds in cereal crops and turf. Other properties, which increase their value as compared with the older herbicides, are that they are reported as being non-poisonous, non-corrosive and non-inflammable.

The response of plants treated with growth-regulating compounds is comparatively slow and varies with temperature.[3] The symptoms of response are epinasty and splitting of stems, curling and yellowing of leaves, arrested flower development, swelling and final rotting of roots.[2, 7]

The most outstanding results achieved so far have been the control of Field Bindweed (*Convolvulus arvensis*) and Perennial Sow Thistle (*Sonchus arvensis*) by aqueous sprays of either " 2, 4-D " or " T.C.P." containing approximately 1 lb. of active ingredient per acre.[2, 7]

Another group of compounds, the urethanes, exhibit growth-regulating activity of a different nature. These compounds have long been known to influence cell division. Templeman and Sexton[6] drew attention to the selective effects of certain urethanes on cereals. Ethyl N-phenyl carbamate applied at approximately 5 lb. per acre to oats sown with charlock, affected the oats but not the charlock. The oats germinated, but growth was arrested after the appearance of the first leaf through the soil. No further leaves appeared, and the seedlings finally died. Under certain conditions, applications of the same compound at rates as low as 1 lb. per acre produced a similar result. The same authors tested fifty aryl carbamic esters and thiocarbamates and found that isopropyl N-phenylcarbamate was the most active.

* 2, 4-Diweed (70 per cent. sodium salt). Sodium 2, 4-D. Chloroxone. Weedone (2, 4-D with an oil base).

Isopropyl N-phenylcarbamate applied as a spray also arrested the growth of winter rye in the pre-booting stage, but had no effect on marigolds, sugar beet, flax, rape and yellow charlock.

In order to obtain a preliminary assessment of the potentialities of these new herbicides in Australia, numerous small-scale tests were laid down in Victoria, New South Wales and Canberra during 1946. The scope of the work was limited during the early part of 1946 by the difficulty of obtaining large supplies of all the compounds.

Tests with Phenoxyacetic Acid Derivatives.

Tests were carried out using aqueous solutions or emulsions of three different phenoxyacetic acid derivatives, sodium 2-methyl 4-chlorophenoxyacetate, sodium 2, 4-dichlorophenoxyacetate and 2, 4, 5-trichlorophenoxyacetic acid. As only small supplies of the latter could be obtained, it was not included in all tests. Sprays were usually applied at a standard rate of 100 gallons of solution per acre at three different concentrations, 1, $2\frac{1}{2}$ and 5 lb. of active ingredient per acre. Tests were also conducted with 1 per cent. " Methoxone " dust at the same three concentrations. The results of these tests are in press and will be published more fully in a Divisional Report of the Council for Scientific and Industrial Research. It was found that the majority of dicotyledonous plants treated showed some reaction to these growth-regulating substances. Monocotyledons generally were less susceptible, although *Asparagus officinalis* is an exception in that the above-ground growth is readily killed by all three compounds. Susceptibility and resistance did not appear to be characteristic of families, but the annual and biennial Cruciferæ, which includes a large number of weeds, showed a high degree of susceptibility.

The response symptoms of plants were, for the most part, as described by overseas workers. In general, young plants growing actively under favourable conditions of temperature and soil moisture were susceptible at lower concentrations than slower growing and mature plants. A number of common thistles, killed by concentrations of $2\frac{1}{2}$ lb. per acre or less in the " rosette " stage, required 5 lb. per acre for a complete kill at the post-flowering stage. Plants sprayed at temperatures below 70° F. often showed little or no reaction, although there was some evidence that an increase in air temperature some weeks after treatment produced a delayed reaction. The time taken for a plant to die depended on the concentrations of the spray (amount of active ingredient per acre), the temperature and growing conditions following spraying and the species of plant. It was found that the period between treatment and death varied from three weeks to three months. The most rapid results were obtained on summer-growing species such as Field Bindweed (*Convolvulus arvensis*), Caltrops (*Tribulus terrestris*) and Bathurst Burr (*Xanthium spinosum*).

The results obtained in these preliminary tests with perennial deep-rooted weeds, such as Skeleton Weed (*Chondrilla juncea*) and Hoary Cress (*Lepidium draba*) showed great variations in depth of root kill between individual plants. Bindweed, which has a similar type of root system, also showed this variation to a lesser extent and resprays will almost certainly be necessary to completely eradicate this weed. More detailed work on Hoary Cress and Skeleton Weed is in progress.

Nutgrass (*Cyperus rotundus*), a monocotyledon, has been killed in pot experiments with 1 per cent. " Methoxone " dust applied to the soil at 500 lb. per acre. Aqueous sprays were in this instance much less effective.

Lucerne and other *Medicago* spp. have proven highly susceptible whereas the annual *Trifolium* spp. have shown a high degree of resistance.

An analysis of the preliminary results obtained indicates that phenoxyacetic acid derivatives may be most successful on summer-growing species, weeds of turf and winter-growing weeds in localities where temperature and soil moisture are not serious limiting factors to plant growth. In areas with prolonged cold winters and ill-defined growing seasons, the period of maximum susceptibility to growth-regulating

compounds may be short, and the successful application of these substances at economic rates may largely depend on the ability of the agriculturist to spray at the correct time. On the western slopes and tablelands of New South Wales, many weeds germinate or, in the case of perennials, commence growth, during the winter. Little top-growth is produced until late spring, when under the influence of higher temperatures, flower stalks are formed rapidly and the plant matures in a comparatively short space of time. Skeleton Weed is a plant of this type and the most effective results to date have been obtained by spraying this plant during the relatively short period between flower stalk initiation and flowering.

Much additional work is required before general recommendations for the use of these compounds as herbicides can be formulated. The outlook is, however, promising and the prospects of controlling some of our most serious perennial weeds, by chemical methods, are more hopeful than hitherto.

Tests with Urethanes.

Only small quantities of ethyl N-phenyl carbamate and isopropyl N-phenyl carbamate were available in Australia, and tests were, of necessity, limited in scope. Aqueous emulsions of both these compounds were prepared by first dissolving in methylcyclohexanol (5 ml. per gm.). Sprays of these compounds containing up to 5 lb. of active ingredient per acre had no visible effect on established plants of Perennial Ryegrass (*Lolium perenne*), Phalaris (*Phalaris tuberosa*), Wallaby Grass (*Danthonia carphoides*), Nutgrass (*Cyperus rotundus*), wheat or oats.

Differential Effects of Urethanes and Phenoxyacetic Acid Derivatives on Seedling Establishment.

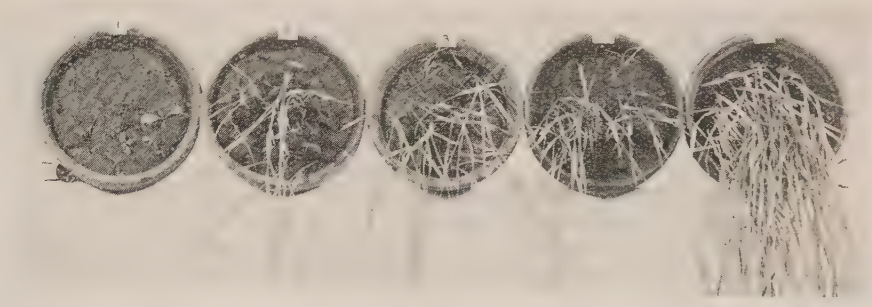
Following the results obtained with urethanes in England, attention was next given to the possible differential effects of urethanes and phenoxyacetic acid derivatives on the establishment of plants when applied at seeding time. Tests to date have shown that isopropyl N-phenyl carbamate applied at 5 lb. per acre to the surface of soil previously sown with oats, wheat or *Phalaris tuberosa* completely prevented the establishment of these species. Ethyl N-phenylcarbamate applied at a similar rate reduced the establishment of wheat and oats by 60-70 per cent. and completely prevented the establishment of *Phalaris tuberosa*. These species germinated successfully, but the first leaf on emergence was short, broad and a deep blue-green colour. The stunting of the first leaves was more marked with plants treated with isopropyl N-phenyl carbamate. The tips of the leaves became brown and finally died without further growth. A noticeable feature was the failure of either carbamate to prevent the establishment of a dicotyledonous weed *Chenopodium carinatum* (see Fig. 1). " T.C.P." applied as an aqueous spray at the rate of 5 lb. per acre to the surface of soils previously sown with wheat, oats and *Phalaris tuberosa* reduced the establishment of wheat by approximately 60 per cent., oats by 20 per cent., and completely prevented the establishment of *Phalaris tuberosa*. " Methoxone " applied in a similar way also reduced the establishment of wheat by approximately 60 per cent. and completely prevented the establishment of *Phalaris tuberosa* but did not affect oats. Both the phenoxyacetic acid derivatives completely prevented the establishment of *Chenopodium carinatum* (see Fig. 1).

" Methoxone " applied at the rate of one-quarter pound per acre in a similar manner to the above did not reduce the establishment of wheat or oats, but completely prevented the establishment of Wild Turnip (*Brassica Tournefortii*).

Discussion.

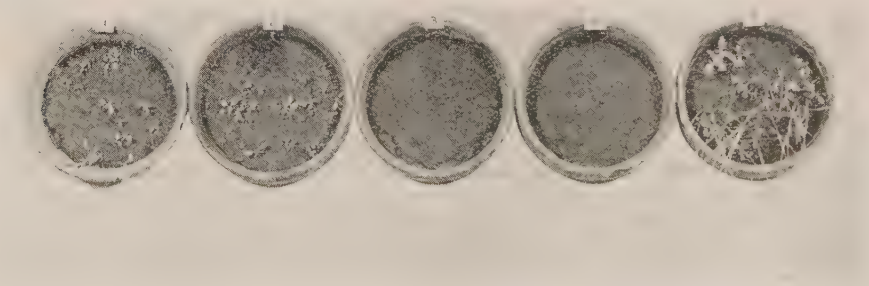
Preliminary tests with growth-regulating substances indicate that these compounds offer promise as selective herbicides in Australia.

The phenoxyacetic acid derivatives have been used with success on a variety of annual and some perennial weeds in N.S.W. and Victoria. Best results were obtained



Wheat. 1. Isopropyl N-phenyl carbamate. 2. Ethyl N-phenyl carbamate. 3. Methoxone. 4. T.C.P. 5. Control. Note presence of *Chenopodium carinatum* seedlings in all pots except 3 and 4, and the reduced establishment of wheat in all treated pots.

Oats. 1. Isopropyl N-phenyl carbamate. 2. Ethyl N-phenyl carbamate. 3. Methozone. 4. T.C.P. 5. Control. Note presence of *Chenopodium carinatum* seedlings in all pots except 3 and 4, and greater resistance of oats to phenoxyacetic acid derivatives as compared with wheat.



Phalaris tuberosa. 1. Isopropyl N-phenyl carbamate. 2. Ethyl N-phenyl carbamate. 3. Methoxone. 4. T.C.P. 5. Control. Note presence of *Chenopodium carinatum* seedlings in all pots except 3 and 4, and the failure of *Phalaris tuberosa* to establish in pots treated with either urethanes or phenoxyacetic acid derivatives.

Figure 1.

Showing differential establishment of wheat, oats and the complete suppression of *Phalaris tuberosa* following applications of urethanes and phenoxyacetic acid derivatives at 5 lb. per acre.

when plants were in an actively growing condition and air temperatures were above 70° F. The outlook for controlling some of our serious deep-rooted perennial weeds is encouraging and Field Bindweed (*Convolvulus arvensis*) has already been controlled to a high degree by applications, at the rate of 1 lb. per acre. The successful eradication of common lawn weeds, reported by overseas workers, has been confirmed.

Although the phenoxyacetic acid compounds have more effect on dicotyledons than on monocotyledons, the latter are not entirely resistant. *Phalaris tuberosa*, wheat and oats have shown varying degrees of susceptibility to heavier application of these substances, particularly at seeding.

The use of these substances both as general and selective herbicides will require judgment and skill and much more research is required before general recommendations as to their use can be made.

Limited tests with two urethane compounds indicated that these substances have a selective action on certain gramineous species when applied at seeding time. Established plants of Nutgrass, cereals and certain grasses showed no reaction to aqueous sprays. If the selective action of urethanes is general on grasses when applied at seeding they may find a use in forest and nursery seed-beds where grasses are often troublesome weeds. Neither of the two urethane compounds used in these tests are available commercially in Australia.

Summary.

The results of small-scale tests with two types of plant growth-regulating compounds are briefly reported.

The possibilities of these compounds as selective herbicides in Australia are discussed.

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Regional Research Stations in Australia

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In considering the possibilities of developing regional research stations in Australia, it is necessary to get a clear understanding of what is implied by the term, then to consider briefly what would be required in the way of staffing and equipment, thirdly the questions of management and general policy, and lastly to attempt to draw from the preceding points the general principles that should guide us in the establishment of further research stations in Australia.

The development of the huge regional research stations in the U.S.A. is commonly mentioned as an example of what might be done here, but the two cases are in no sense parallel. Although the area in each case is about the same, in Australia it is divided into six states and one territory, as compared with America's forty-eight states. As a result several American states may constitute one natural region, whilst most of the Australian states embrace more than one, and commonly several,

natural regions. In some cases in Australia also, the natural regions cross the state boundaries.

All consideration must, of course, be against the background of Australian geography ; the great distances that require regional effort and the sparseness of population which enhances the isolation from which that effort suffers.

Function of a Regional Station.

What is a regional research station ? Is it a station designed to enquire into one particular problem, affecting one region only, like the old Rice Research Station of the N.S.W. Department of Agriculture at Leeton ? Or is it a station at which attempts will be made to study several or all of the problems affecting primary production in that region ? For a small region the best Australian example is probably the Irrigation Research Station at Griffith, N.S.W., but to a greater or less degree the State Departmental Laboratories and the Universities have functioned as regional research laboratories. The Waite Institute to a very considerable degree has served as the regional laboratory for the South Australian region, since its investigations have extended into each of the three major natural regions of South Australia. Is the regional research station a station intended to supply the answers to the settlers' immediate problems, or is it to undertake the more fundamental problems of a particular region that are of too long a term or too great a magnitude to be attempted by the States' advisory services ? The diversity of the problems it is desired to attempt, rather than the present population and productiveness of the area, should determine the size, staffing and complexity of the institution that is to be developed.

On the other hand, it may be desired not merely to study the problem or problems of one region—but rather to study the influence that the varying environments of Australia are having on primary production in the different regions. The shorter cycle of growth in the tropics than in temperate climates—the longer period of growth in humid than in arid localities—the variations in temperature and available moisture—and the variations from year to year in either of them—are factors which affect such diverse things as the power of the soil to supply nutrients, the incidence of plant disease, of insect plagues, and the composition of pastures, on which in turn depends the health and productivity of grazing stock. Obviously, it is impossible to forecast from the results obtained under one set of environmental conditions what will happen when the environmental conditions are changed in one direction or another.

The Need for Regional Stations in Australia.

As Dr. Dickson pointed out at the 1945 general meeting of the Institute, literally all of the agricultural research stations are situated in the southern part of the continent, and results obtained there will be of little if any value in attempting solution of the problems affecting the north. Clearly, therefore, if the object of the research stations is to gather fundamental information on the effects of different conditions of temperature and humidity, of length of growing period, of wind intensity, and different soil conditions upon the growth and health of the domesticated crops and stock, there is need for a co-ordinated grid of research stations, distributed across the continent. These need not necessarily be equidistant from each other, but covering effectively the range of environmental conditions encountered throughout Australia. Since water supply will normally exert an effect on plant growth entirely independent of temperature, an attempt should be made to locate the research stations of each region in a place where facilities for irrigation can be obtained. This is not to imply that irrigation in each area will be expected to be an economic or practical proposition, but rather that by its use on the research station, control of another variable in crop growth can be obtained.

The Present Position.

The development of agricultural research in Australia in the past has been on a regional basis only so far as the States can be considered as regional units, and with certain exceptions the research activities of the State departments have been of short term character, the effort expended on fundamental observations being small. It was largely in recognition of this weakness that the Commonwealth set up the Council for Scientific and Industrial Research to undertake fundamental investigations in different fields. In this case the development again has not been on a regional basis. As the Council grew, the research laboratories were developed to deal with various aspects of agricultural production—animal health and nutrition, soils, plant industry, and so on—with strong central laboratories located for various reasons in one or the other of the capital cities of the south-eastern corner of the continent. In no case was their location affected by considerations of natural regions, and although the subsequent development of field stations carrying staff from more than one division contains the regional idea in embryo, the attack on agricultural problems on a regional basis would require that the staffing and equipment of existing or proposed laboratories should be specifically directed to this end.

The concept of regional research can and will be discussed in many places. Here it is only desired to present for discussion some of the material details implicit therein ; by a more quantitative approach it may be possible to make our resources equal to the problems before them.

Size of Regional Research Stations.

The advantages of regional research stations may accrue either from the magnitude of the individual research station—the size of staff and diversity of facilities each affords—or they may be due to the variety of environments offered to the peripatetic research worker, who will run his plots and experiments on a series of different stations.

There are thus the two extreme types of regional research stations :

(*a*) Those with a relatively large staff, well equipped laboratories and library, adequate experimental areas, etc., and

(*b*) Those smaller ones—say, attached to a demonstration farm, supplying merely laboratory space and sleeping quarters for the temporary workers, whose permanent residence and headquarters are elsewhere. In this case, a manager or farm director and the farm staff need to be in residence all the year round.

The Relative Advantages of Each Type of Organization.

In the large self-contained unit, the staff has the advantage of living with the problem, of intimate contact with the settlers on whose properties the problems are occurring, and will receive constant inspiration from their contacts with farm practice.

These regional research stations will normally be located in or adjacent to small towns, and consequently little time will be wasted in travelling to and from work—particularly if this is remembered in selecting the site—and it will be easy for the keen man to work back occasionally if he wishes.

The experimental fields adjacent to the station enable experimental crops and plots to be kept under close personal supervision, and things stand a better chance of being done at the *best* time, from the point of view of the problem, rather than when they can be most easily fitted in with farm work. The different variables are thus more completely under the control of the experimenter.

Nevertheless, certain difficulties occur, and the area available at the station has in the past generally been found to be inadequate for all the claims made on it. Demands for water, labour, machinery and particular areas will frequently clash.

The larger the personnel or the greater the number of problems being studied, the more likely are these clashes to occur—a factor to be borne in mind in considering the major projects for which the station is being built.

Some things can be done to alleviate these difficulties—the provision of a plentiful supply of power in the form of tractors will obviate one bottleneck, the small petrol or electrically driven, hand-operated multi-purpose machines, such as the autocultivator, with its various attachments, reduce the time taken to lay out the numerous small plots necessary for modern field experiments. Miniature harvesting machinery fitting on to the same frame and wheel base will add speed and precision to the small-plot work, as well as relieving demands for labour (and not too unskilled labour), during critical times.

One other advantage of this type of organization is that since all the workers concerned are located at the same time in the same region, the implications of each piece of work on other facets of agricultural production can be seen. One result of this, which can frequently be found in the papers now coming from the American regional laboratories, is that the experiments are designed to allow of study by several workers. For example studies developed primarily to afford information on manurial requirements can at the same time afford information on effect of manures on nutrient content of the crop, and of the interaction of manure and crop on soil structure and biotic activity, and of all these on the incidence of plant disease. In the same way grassland studies can be undertaken with reference to the grass and stock and the husbandry practised, and the effect these have on the soil. Whilst theoretically there is no reason why similar coordinated studies should not be undertaken apart from regional research stations, the gathering together of workers of different fields of agricultural science in the regional laboratory makes the joint attack more probable.

At the other extreme from the self-contained regional research laboratory is the simple field plot, extended as a grid of plots across the countryside to enable study to be made of the effects of different environment. In some cases these plots have in the past been located on various privately owned farms, and consequently subject to the usual errors arising from lack of supervision. A better arrangement is a group of field stations, located specifically to allow environmental influence to be studied.

In this case little is required in the way of laboratory equipment other than bench space and electricity, gas and water services, since the visiting workers can bring most of their equipment with them, especially if adequate motor transport is available from their home laboratory. To some extent the experiment farms maintained by the Department of Agriculture would enable this type of study to be undertaken in New South Wales, although the " grid " they afford could be extended. Not all possess adequate laboratory facilities and in most the equipment for recording climatic data requires to be considerably increased. The small scale, self-powered machinery for sowing, manuring, spraying, cultivating and harvesting, etc., referred to earlier, plus a 30 cwt. utility truck, will also enhance efficiency when plots are to be laid out at several such centres. The information that can be obtained by this simpler type of " regional laboratory " differs in obvious ways from the studies that can be undertaken at the large self-contained regional units, but the value they give at relatively low cost should not be overlooked if a regional approach to agricultural research in this country is to be adopted.

It should be equally obvious that if husbandry or management experiments are to be carried out on these centres the areas of land embraced may require to be considerably greater than any existing experiment farms.

Establishment and Equipment of the Regional Research Station.

The efficiency with which the work would progress depends upon several factors :

(*a*) Type of work—whether equipment is adequate.
(*b*) Adequacy of technical and unskilled assistance.
(*c*) Adequacy of the field, laboratory, or glasshouse space available.

(*d*) Library and clerical facilities.
(*e*) Personal relationships and conditions in the station.

The first four of these depend upon one thing—whether the work of the station is independent, or whether it is to be related to the work of some central research laboratories, situated, say, in the capital cities or in another region. Secondly, whether the regional laboratory is to be concerned mainly with the problems immediately facing the farmer, or whether an honest attempt is going to be made to investigate fundamental relationships. It is obviously to the interests of the community as a whole that the funds available be spent to the best possible advantage. Clearly, we cannot establish in every distinct natural region a laboratory capable of attempting problems in all fields of agricultural science. Rather should we attempt to make each regional research laboratory the centre for the attack on one group of related problems, providing at the same time facilities for it to act as a field station for a wide variety of others. It is better, surely, to plan each place to do its specific job properly, rather than to have them all in the same state of equal mediocrity.

One advantage of the regional research station is the ease of transport, when as usual, numerous samples have to be examined and/or analysed. This advantage is nullified unless, as in the cases where analysis is required, adequate provision is made for drying, grinding and sampling the material. The major disadvantage of the present system is the centralization of samples, queries and " specialists " in " head office " in the capital cities, inevitably remote from the problems.

Another factor which may restrict the development of the regional research stations is the high initial cost of modern physical and chemical equipment. Yet, unless these regional laboratories are adequately equipped, the value of the work they can do—not only in the chemical field but in all those other fields that require at one time or another numerous chemical analyses—will be seriously reduced.

Problems of Staff.

Problems affecting staff seem to present some of the most serious difficulties. If we are willing to pay enough, we know we could equip adequately, say, 100 regional research stations at a cost of, say, one-fifth of the war expenditure for 1945. But we could not adequately staff them—perhaps not in twenty years. The key man, the officer-in-charge, should be able to inspire the work of the whole team, and to some extent to guide their work. At the same time he should be able to encourage their individual development and to remove the obstacles in their way, yet giving to each a feeling of responsibility for the work that he is doing. How many people measure up to these standards? Isn't this really the most seriously limiting factor to the number of larger stations we can set up?

The final disability under which the regional laboratory will suffer is that of isolation—of physical isolation in the difficulty of replenishing stocks of materials, and the mental isolation from lack of contacts with one's fellow workers. The equipment and maintenance difficulties can be largely reduced if the central organization functions with a minimum of red tape.

The mental isolation is more difficult. The larger the staff at the research station, the less is the individual isolation, but the fact of its existence is frequently not appreciated, particularly in political and departmental circles. It can be overcome by periodic and not too infrequent trips to other stations and other centres—not as a favour, but with the clear realization by authority that these are no mere pleasure trips but are an essential part of the expenditure necessary for the maintenance of the station in full working efficiency. There is a tendency also to consider the worker as the unit, and not to realize that really it is the worker and his family that constitutes the unit. In the absence of some over-all change in our social system, provision for the research worker's wife to accompany him on these study periods must be made—the expenses of her travel and maintenance of the children in boarding school or nursery should be borne by the organization. Otherwise it

means discontent and unhappiness in domestic affairs, both of which will detract from the efficiency of the worker concerned.

Another point concerns the provision of houses, which should not be located on the research station or experiment farm. Excessive proximity of a small group is not good, and personal relations seem to be better when the staff are not forced to see too much of each other outside working hours. No man is a hero to his valet, and few to their subordinates, whilst even fewer women are heroines to their next-door neighbours—so let us avoid, in planning our stations, these points of friction.

Organization and Control.

Lastly comes the question who is to institute, manage and govern these regional research stations? The answer depends in part on how clearly we have defined their purpose. If the station is concerned with the *ad hoc* investigation of the problems of the settlers, then it must inevitably be associated with the advisory and extension work on these problems. In this case it must be a State organization, unless the extension officers are merely to pass on advice doled out in turn to them by the research workers. If, on the other hand, the principle purpose is to locate research stations in each major natural region to conduct fundamental investigations—including the influence of environment on the problems of agricultural science, then it moves into the Federal sphere, since the natural regions in general do not follow State borders. Nevertheless, it would be a major tragedy if these regional laboratories were to grow up divorced from the day-to-day problems affecting the settlers, and hence the extension officers in each region. Since extension work is, to a considerable degree, an aspect of tertiary education, use might be made of the universities as the cement to hold together the efforts of the State and Federal authorities in this matter.

In each State, the University should be built up to contain a research unit of the size and calibre of the Waite Institute, or larger. This can be done by transfer of State officers concerned in research to the University, and supported by a State grant. The C.S.I.R. laboratories associated with the Universities, and concerned with agricultural problems would become research institutes of the Universities, though still financed by Federal grants. This joint body, made up of University Faculty and Research Institute, would be governed by a particular committee, called, say, the Agricultural Committee of the University, and with representation on it from the University Senate, the Faculty of Agriculture, the State Department of Agriculture, and the Executive of C.S.I.R. The University Faculty of Agriculture and its associated research laboratories could then function as the central research unit, and could establish regional research laboratories, as seemed desirable, the boundary of the natural region, rather than the State boundary delineating the area concerned. The whole of the extension work should now be centred on these regional laboratories, and at least the chief extension officer for each region actually having his office in the regional research laboratory. The advisory services being financed by the States as at present.

Finally, an increase in efficiency and interest would result if each region could be made to a large degree self governing, with a governing committee representing in part the parent University Agricultural Committee, in part the research and extension staff, and in part representatives of the local government bodies of the region, or of producers' organizations. This regional committee would be the appointing body for the region, thus making it possible for a brilliant individual by transfer to achieve high rank at a relatively early age, and overcome the bugbear of our public services: promotion by seniority only.

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Technical Notes

ZINC TOXICITY IN FLAX GROWN IN A WIRE NETTING " BIRD CAGE."

An instance of zinc toxicity has occurred at Burnley Gardens in flax plants grown in a large cage of narrow mesh galvanized wire to protect them from birds. According to Harris,[5] Dr. Brenchley has stated that occasional failures in such cages have occurred, and have been attributed to zinc poisoning. For this reason, galvanized iron " bird cages " at Rothamsted are painted.

The soil concerned at Burnley is a grey sandy loam (pH 6·0). Although the disease has been prevalent in summer sowings, its effects have been most severe in the winter, particularly if it is very wet and cold. It has been observed that whereas flax has shown very severe symptoms, common weeds, notably *Fumaria officinalis*, growing amongst the affected flax plants have appeared quite normal.

Symptoms.

The earliest symptoms have been noted three to four weeks after emergence. They usually consist of a marked chlorosis of the top of the plant associated with a retardation of growth. However, dwarfing may occur without any marked chlorosis. Later, the lower leaves become necrotic. This necrosis usually commences at the tips, but sometimes first appeared as spots on the undersides of the leaves. Meanwhile the top of the plant develops a rosetted appearance due to the reduced length of the internodes. Usually the primary stem finally dies from the top, and the plant sends out fresh shoots from the basal node. While these shoots usually develop the symptoms described above, it has been observed that some of them may show no signs of chlorosis and make apparently normal growth and produce a good yield of seed, even though the primary shoot and sometimes the first shoot from the basal node may be quite dead. This recovery of the plants appears to be associated with the onset of warmer and drier weather in the spring. It is of interest to note here that flax plants suffering from lime induced iron deficiency during winter months may also manifest a recovery in the spring.[11]

Effects of Various Treatments.

It was found that the disease could be prevented by treating the soil with one ton of hydrated lime per acre before sowing, whereas it was considerably aggravated by applications of 10 cwt. of sulphur per acre or by 1 cwt. of zinc sulphate per acre. Spraying the chlorotic plants with a 0·5 per cent. solution of iron sulphate resulted in the temporary development of a normal green colour on the chlorotic leaves, but the general growth remained stunted.

The following treatments applied separately or in combination with superphosphate had no influence on the incidence of the disease : superphosphate 1 cwt., sulphate of ammonia 1 cwt., magnesium sulphate 1 cwt., potassium sulphate 1 cwt., manganese sulphate 1 cwt., or borax 20 lb. per acre.

Although the disease was prevented by the application of lime, the symptoms manifested by the affected plants were not those of calcium deficiency.[10] It was apparent that the opposite effects on disease incidence of lime and sulphur respectively were related to changes in the soil reaction produced by these treatments. The chlorotic phase of the disease was evidently due to an inefficient utilization of iron by the plant, but the lower leaf necrosis of the plants was not characteristic of the iron deficiency disease which has been produced in water cultures at Burnley. Furthermore, an iron deficiency induced chlorosis which was brought about by an inadequate absorption of this element from the soil would normally be aggravated by raising the soil pH by the application of lime,[19] whereas in this instance liming prevented the appearance of chlorosis.

The effects of various treatments set out above strongly suggested that the disease was due to an excess of zinc in the soil. The availability of zinc in the soil decreases rapidly with increase in pH.[8, 12] Liming is therefore effective in alleviating zinc toxicity.[4, 17, 16] The sandy nature of the soil concerned was probably also conducive to zinc toxicity, as it has been shown that the fixing power of such soils for zinc is relatively not great. Thus Baumann[1] found that a much lower concentration of zinc was toxic in sandy soils than in humus and marl soils. Similarly, Gall and Barnette[1] observed that the toxic concentration of replaceable zinc was much greater in clay than in sand.

Water Culture Experiments.

Water culture experiments have been conducted to determine the symptoms in flax resulting from the addition of excessive amounts of zinc (5, 10, 20, 25, 50 and 100 parts per million respectively) to the nutrient solution. The results of these experiments will be reported in greater detail elsewhere.

Figure 1.
Iron deficiency chlorosis produced in water culture by the addition of excess zinc to the solution.

It was found that symptoms identical with those exhibited by the affected plant growing in the " bird cage " were induced by the addition of an excess of zinc to the nutrient solution. The plants became dwarfed, and a marked chlorosis of the younger leaves occurred (Figure 1). These initial chlorotic symptoms appeared to be identical with those of iron deficiency. By way of confirmation, it was found that it was possible to prevent entirely the development of this chlorosis of the top of the plant by applying additional iron to the solution at the same time as the excess zinc was added. However, even with the additional iron the plants remained dwarfed.

Where death of the top of the plant occurred, it was due to severe iron deficiency. Chapman *et al.*[3] have reported that an excess of zinc or a slight excess of copper caused iron deficiency chlorosis in citrus. High concentrations of zinc were also found to be associated with iron deficiency chlorosis in tomatoes by Walsh and Clarke.[18]

The secondary symptoms in flax produced by excess zinc consisted of a necrosis which commenced at the tips of the lower leaves and was brown in colour. A slight yellowing of the affected tissues usually preceded the appearance of the necrosis. In some instances, the first signs of the necrosis of the lower leaves consisted of numerous small bronze to brown coloured spots on the under surfaces of the leaves

(Figure 2). This lower leaf necrosis occurred even when the development of iron deficiency had been prevented by supplying additional iron to the solution. Such plants resembled many seen in the " bird cage " which showed little or no top chlorosis, but were dwarfed and with necrotic lower leaves.

Root development of the flax plants grown in the presence of excessive amount of zinc was seriously curtailed. In this respect, the toxicity of excess zinc was much greater than excess manganese, but less than excess copper.

Figure 2.
Lower leaf necrosis of flax grown in water cultures with excess zinc.

Zinc Content of Plants.

Analyses of the zinc and iron contents of six weeks old chlorotic and non-chlorotic plants from the " bird cage " were made in the State Laboratories under the direction of Mr. W. R. Jewell. The non-chlorotic plants obviously were not normal, being but slightly taller than the stunted chlorotic plants. The results of these analyses on dry basis are given in Table 1.

TABLE 1.
Analyses of Chlorotic and Non-chlorotic Plants from the " Birdcage ".

Constituent.	Chlorotic Plants.	Non-Chlorotic Plants.
Phosphoric acid (P_2O_5), parts per 100,000 ..	914	1,001
Iron (Fe), parts per 100,000	57	37
Zinc (Zn), parts per 1,000,000	812	688

The zinc content in both samples of plants was very high, but greater in the chlorotic plants. A contrast with these high zinc figures is given by the results of

Piper and Walkley,[13] who found the zinc content of normal flax plants of approximately comparable age to be about 30 parts per million on dry basis.

A feature of the results is the fact that the iron concentration was actually higher in the chlorotic than the non-chlorotic plants, indicating that not iron absorption, but its utilization in the tissues, was unfavourably affected by the excess zinc. Rippel,[14] Hendrickson,[6] Milad[9] and Chapman[2] have shown that leaves manifesting symptoms of iron deficiency chlorosis may actually contain a higher iron content than normal.

It has been shown by a number of workers, and also in unpublished experiments at Burnley, that excesses of either manganese, copper or cobalt, will also induce iron deficiency chlorosis in plants. Somers and Shive[15] claim that this effect is due to the manganese (or cobalt) catalysing the oxidation of physiologically active ferrous iron to the inactive ferric form, and the probable formation of an insoluble ferric-phosphorus-organic complex. However, with regard to this hypothesis Leeper[7] points out that Somers and Shive's view of the mechanism of the oxidation of ferrous iron to the ferric state is quite fallacious.

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THE USE OF SELENIUM IN NEMATODE CONTROL.

The foliage disease of chrysanthemums caused by the nematode *Aphelenchoides ritzema-bosi* (Schwartz) Goodey was recorded for the first time in New South Wales in 1930.[3] Since then it appears to have spread slowly and is now the chief cause of leaf injury to this crop in at least one flower-growing district in this State.

In dry seasons the disease appears to be of relatively slight importance and the routine nicotine sprays applied for aphid control probably help to reduce its rate of spread. In damp weather when foliage growth is luxuriant, very severe damage is caused and the parasite may kill all the leaves and invade the flower head. This type of injury is easily recognizable but without the aid of a microscope slight and moderately severe types of damage may be difficult or impossible to distinguish from the common and widespread leaf spot caused by *Cylindrosporium chrysanthemi*.

Figure 1.
Chrysanthemum leaf affected with foliar nematode disease.

The standard treatment[2] is to steep infected crowns in warm water (43·5° C. for 20 minutes). Though found to be completely effective here, the method is not applicable on a large scale.

According to a preliminary report, Dimock[1] found that selenium gave control of foliar nematode in the United States. Consequently an experiment was set up to test the efficacy of this treatment.

Rooted offsets from infected crowns were planted in 6-inch flower pots and grown in a glasshouse. Four weeks later, when the plants were well established, twelve pots were watered with a solution of sodium selenate. A measured amount of a 0·25 per cent. solution of sodium selenate was sprinkled evenly into the surface soil, the amount given being enough to result in a concentration of approximately 25 p.p.m. in the soil on a dry weight basis. Twelve pots were left untreated.

Results.

The solution used proved to be too concentrated, as it caused the development of symptoms of toxicity. These took the form of numerous small circular dead spots up to 1 mm. in diameter evenly spaced over the leaf blade. Subsequent growth was unaffected.

The treatment completely inhibited the development of the nematode in all the treated plants. Over a period of seven months during which the plants were under observation it also protected them from the attacks of jassids, caterpillars and aphids, all of which attacked the untreated plants. All the untreated plants developed moderate to severe symptoms of nematode disease.

A field trial using less concentrated solutions of sodium selenate is in progress.

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THE COMPARATIVE THICKNESS OF MEDULLATED AND NON-MEDULLATED FIBRES IN CORRIEDALE WOOL.

Fleece fibres are classified on their structure and on the important events in their careers, particularly the times at which they commence growth and whether or not, at a certain age, they cease growing and are shed. In the first instance, discrimination is made on the presence or absence of a central layer of medulla, in addition to the cortical and cuticle layers. Continuously growing non-medullated fibres are known as "wool". Continuously growing medullated fibres have been referred to as "hair", but that term is used more widely and rather loosely in Australian wool circles to indicate undesirable coarse fibres, whether medullated or not. Medullated fibres which grow for a limited time before being shed are known as "kemps". Fibres which are part medullated and part non-medullated are referred to as "heterotype". The Australian merino is relatively free from continuously growing medullated and heterotypic fibres, whereas in the Corriedale breed their presence in definite proportions (e.g. 4 per cent. and higher) of the total fibre population is reported.[3]

There are several general assumptions which are commonly made concerning medullated fibres of persistent growth. Wilson[4] states that a positive correlation exists between "hair" shaft diameter and the presence of medulla. Hausmann[2] after studying the coats of two hundred mammals, suggests that as wool fibres become coarser the presence of medulla becomes more frequent. The most common type of heterotypic fibre has a medullated distal and a non-medullated proximal portion, the former being usually of greater diameter than the latter.[1] It has become accepted, therefore, in many circles that if medullated fibres are present they form the coarse fibre group in the frequency distribution curve of fibre thickness.

The preparation of frequency distribution curves for fifty different Corriedale samples representing the whole range from medulla-free to heavily medullated staples and the differentiation of the distribution of medullated fibre thickness from that of the staple as a whole, has provided some interesting information. (Two hundred and fifty measurements of fibre thickness were made at 500 diameters across each staple half an inch from the butt.) The following facts were observed :

1. When medullated fibres were present in a proportion of less than approximately 7 per cent. of the total, they were never included among the coarser fibres of the distribution. They were distributed mainly within the region M to $M+\sigma$* and completely within the $M-\sigma$ to $M+2\sigma$ region (Fig. 1A).
2. As the proportion of medullated fibres increased beyond 7 per cent., the range of their distribution increased until it extended in most cases from $M-2\sigma$ to $M+3\sigma$. In odd cases the upper limit was greater than the latter. Thus although medullated fibres were present among the coarsest fibres, they also occurred among the average and finer fibres, but never among the finest (Fig. 1b).
3. When more than approximately 15 per cent. of the total sample was medullated, these fibres became the coarser fibre group completely. However, many of their number still occurred down to the $M-\sigma$ portion of the range of distribution, and in the typical asymmetric distribution of these wools, with a positive skewness of approximately 1·0 the upper limit of their range might extend as far as $M+4\sigma$ (Fig. 1c).
4. The mean contours $\left(\text{Contour}=\frac{\text{Major axis}}{\text{Minor axis}} \text{ of the fibre cross section}\right)$ of the medullated and non-medullated components of any sample did not indicate that the medullated persistent growth was more elliptical than the non-medullated. This is interesting in view of the fact that the shed

* M=mean thickness of all the fibres. σ=their standard deviation.

medullated fibres—the kemps--are reported as being on the average more elliptical than the wool component of a fleece.

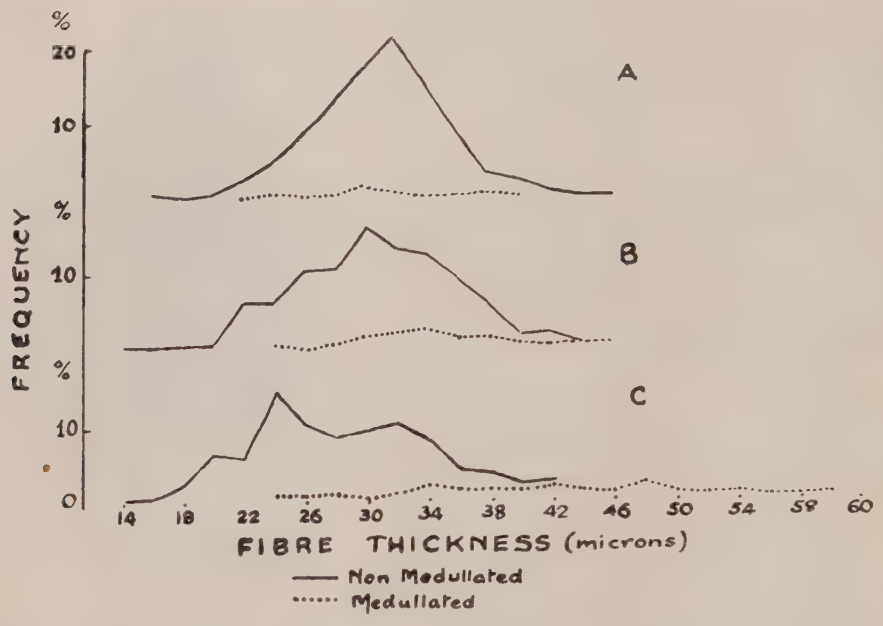

Figure 1.
Frequency distribution curves of fibres in three samples of Corriedale wool with different proportions of medullated fibres.

The above therefore indicates a qualification to the generally accepted idea that continuously growing medullated fibres are the coarser fibres in the staple. It emphasizes that some of these medullated fibres may have a thickness less than the mean of the whole and when present in small numbers may not occur at all in the upper limits of the distribution. It also suggests that there is no significant difference in fibre contour between the two groups, which could conceivably cause differences in spinning efficiency and with the other data is evidence in favour of the contention that in Corriedale wool the presence of small percentages of medullated fibres is not likely to be detrimental to the spinning performance. However, where above 15 per cent. of the total is medullated, the disparity in fibre thickness may affect such a conclusion and should be noted.

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THE NUTRITIVE VALUE OF SOME NORTH AUSTRALIAN GRASSES.

Studies on the chemical composition of pastures, and the seasonal variations therein, that were initiated at Cambridge by Woodman and his colleagues demonstrated effectively both the high nutritive value of young pasture grass and the decline in nutritive value that took place on maturation.[7] This decline is relatively rapid even under the cool and moist English climate, the protein content of mixed pasture falling from 26 per cent. in spring to 8 per cent. in summer.

Where climatic conditions are not so favourable to continuing vegetative growth the decline is both more marked and more rapid. Thus for *Phalaris tuberosa*, grown in Adelaide, the protein content declined from 33·0 per cent. in the early tillering stage to 3·37 per cent. at maturity.[6]

In the wet tropics (Trinidad),[5] elephant grass (*Pennisetum purpureum*) gave at its best only a protein content of 14·6 per cent., declining to 4·3 per cent. at maturity, and even monthly cutting did not keep it above 10 per cent.

In northern Australia, the short summer rainy season and the long severe winter drought precludes any attempt at close grazing on the English pattern, or even of " soiling " on the West Indian system, and the herbage rapidly reaches the mature state. The great bulk of the mature herbage is not utilized at all, and the cattle exist through the dry season by picking at small green shoots arising from root reserves and residual soil moisture, and by getting a little feed in such relatively favoured spots as along river and creek banks and around water holes, lagoons and swamps. The samples of grasses of which analyses are given here were collected in the Katherine area as part of an investigation requested by the Army in 1943. Although having no pretensions to completeness, the figures appeared to be of interest because of the very low values found for certain nutrients. They were taken when the plants were in the flowering stage, and the mature material might be expected to be of even lower nutritive value. The samples represent eight different species, and were collected by random sampling in fine weather, air dried fairly rapidly in the shade, and a composite subsample obtained. The data obtained are summarized in table 1.

Chrysopogon latifolius S. T. Blake.

Broad-leaf speargrass is a comparatively late flowering, perennial tussock grass ; few tillered and with a somewhat bulbous base. Leaves 10 mm. wide and normally a bright shiny green. Quite leafy and apparently useful up to the flowering stage, when this sample was taken. In the area visited it was almost invariably confined to heavier soil types and somewhat favoured situations. Commonly found in association with Kangaroo Grass, which appeared to be the normal co-dominant in such an environment.

Chrysopogon pallidus (R.Br.) Trin. ex Steud.

Narrow-leaf speargrass is an early flowering perennial tussock grass, many tillered and with a somewhat bulbous, woolly base. It is of medium height and very leafy, but the leaves are only 2-3 mm. wide, dull green in colour, and very harsh. Associated with *Themeda australis* on medium textured soils ; with *Sorghum stipoideum* coming in on the sandy loams, and *Brachyachne convergens* on shallow limestone outcrops. Obviously hardier than the broad-leaf type, and extending into lower rainfall country.

Themeda australis (R.Br.) Stapf.

Kangaroo grass is a perennial tussock grass. On the Katherine it is a mid-season grass, multi-tillered and very leafy. Reputedly useful up to the flowering stage, when this sample was taken. (Sample A.)

A second sample (Sample B), noticeably finer in texture than the first, was taken from the association with the *Chrysopogon latifolius*.

Brachyachne convergens (F. Muell.) Stapf.

A rather early flowering, low-growing, tufted annual grass. Forms a partial ground cover in the wet season on shallow soils where limestone outcrops, or on disturbed sandy areas. In Queensland it is known as Native Couch or Gulf Star Grass. In the Northern Territory and around the Gulf of Carpentaria it is looked on as a useful fattening grass, although in southern Queensland it has been reported to contain a cyanogenetic glycoside.

This sample was taken at the flowering stage.

TABLE 1.

Analyses of Grasses from Northern Australia.

Species and Stage of Growth.	Composition of the Dry Matter.							
	Crude Protein.	Crude Fibre.	Ether Extract.	Soluble Carbo-hydrate.	Ash.	Insoluble Ash.	CaO.	P_2O_5.
	%	%	%	%	%	%	%	%
Chrysopogon latifolius (flowering stage) ..	3·90	52·10	0·64	35·82	7·35	6·54	0·129	0·11
Chrysopogon pallidus (late flowering stage)	4·56	51·31	—	34·30*	9·22	8·28	0·116	0·139
Themeda australis (flowering stage)—								
Sample A ..	3·43	49·55	—	39·55†	8·16	7·02	0·178	0·080
Sample B ..	4·09	46·27	—	41·59	8·32	7·40	0·135	0·106
Brachyachne convergens (flowering stage) ..	8·68	35·42	1·26	40·33	14·88	13·23	0·229	0·090
Sorghum stipoideum—								
At 18 in.-24 in. high	3·27	41·79	—	47·52†	6·67	5·90	0·365	0·142
At flowering stage	1·89	52·22	0·67	40·66	4·49	—	0·263	0·134
Cyperus rotundus—								
At the leafy stage	13·79	28·25	2·70	42·91	12·16	—	0·498	0·458
At flowering stage	8·83	30·85	2·20	48·22	9·50	7·52	0·361	0·185
Ichnanthus pauciflorus—								
At flowering stage	7·24	36·55	—	48·23†	10·04	8·76	0·262	0·216

* To obtain this figure, the ether extract is assumed to be as in Sample 1.

† Carbohydrate figure includes ether extract, which is unlikely to be more than 1-2%.

Sorghum stipoideum (Ewart and White).

Tall Speargrass, Strawgrass or Sorghum is a mid-season, annual, tall-growing tussock grass. Fairly leafy and wheat-like in the early stages of growth, but developing into few, coarse-leaved, fragile, strawy plants. Under normal conditions growing up to eight feet high at flowering. On deep, light-coloured sandy soils of the Katherine area, this species occurs in almost pure stands in savannah association with Cypress pine (*Callitris intra-tropica*). It is considered useful fodder only until about one foot high, i.e. in the first month to six weeks of the wet season.

Two samples, one at flowering stage and one leafy, eighteen inches to two feet high, were collected for analysis, but from slightly different associations in the same locality.

Cyperus rotundus L.

Nutgrass is a perennial sedge, with creeping rhizomes swelling here and there into tubers. Indigenous to most tropical and temperate regions. It was observed in quantity only in the immediate vicinity of Manbulloo homestead, but also occurs along the river banks. It is reputed to produce some out-of-season green feed.

Two samples were collected, one at the leafy stage some time before flowering and one at the flowering stage.

Ichnanthus pauciflorus (R.Br.) Hughes.

This is a small annual early-flowering tussock grass, quite leafy and possibly important in feed production early in the wet season. It occurs somewhat prominently in association with *S. stipoideum* on sandy loams in the vicinity of the river.

The low protein, calcium and phosphorus contents of most of these samples are noteworthy, particularly since they were obtained at the flowering stage or earlier. Phosphorus and protein could consequently be expected to fall further as the season advanced. For comparison, the lowest values reached for natural pasture at Kybybolite,[1] in the south-east of South Australia, was :

Crude protein, 5·8 ; CaO, 0·40 ; P_2O_5, 0·12 ; and for Mitchell Grass at Winton, central Queensland[2] :

	Crude Protein.	P_2O_5.
At flowering stage	16·6	0·329
Lowest figure reached	4·0	0·091

Under South African conditions, Du Toit[3] reported that the crude protein was insufficient for growth when its level falls below 4·5 per cent. Pastures between 5 per cent. and 7 per cent. permitted limited growth whilst those over 7 per cent. allowed what he considered normal growth. In a similar study of production under range conditions, McMillan, Williams and Langham[4] obtained low livestock gains on pastures of 6-8 per cent. crude protein, whilst above 13 per cent. live weight gains and production were good.

The effect is probably not simply one of adequacy of the protein supply, since there is a positive correlation between the crude protein figure and the starch equivalent. The low levels reported here for *Chrysopogon, Themeda australis* and *Sorghum stipoideum* suggest that in pastures in the north composed largely of such species, pasture quality must be a limiting factor in livestock production unless supplementary grazing on other species is possible. As the minor species, particularly scattered small native legumes, become eaten out the position becomes critical, even although the country is carrying a great bulk of herbage.

The low phosphorus figures are also surprising, since aphosphorosis has not been reported from this area, although comparative figures for N.S.W. and Western Australia would suggest its likelihood, e.g.

Poor quality pastures	0·154-0·276 per cent. P_2O_5
Good quality pastures	0·269-0·550 „ „ „

Its absence may be due to selective grazing of other species (e.g. *Ichnanthus*) or to the fact that the energy supplied by the grazing permits only such a slow growth rate that the phosphorus supply does not become limiting.

One other point worthy of comment is the high silica content of these grasses, as shown by the " insoluble ash " figures. This has been noted in other tropical

grasses, and may be a cause of the distaste stock may show for a grass which from its relatively high protein content would be otherwise desirable.

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STARCH DEPLETION AND DEATH OF SPOTTED GUM TREES.

During 1938, experiments on high ringbarking of spotted gum (*Eucalyptus maculata* Hook.) were commenced on the Barakula Forest Reserve about forty miles north of Chinchilla. This treatment successfully caused complete starch resorption in the sapwood of the trees below the ring and rendered the wood immune to attacks by the powder post beetle (*Lyctus brunneus* Steph.).

Spotted gum is not a difficult species to kill by the normal method of ringbarking at breast height, and initially, in the high ringbarking work, it was feared that the trees would readily die, possibly before starch resorption was complete. However, it was found that the trees were still alive when all starch below the ring had disappeared. The starch resorption was found to be comparatively rapid : in one experiment, commenced in August, 1938, complete depletion occurred in most trees within six months and in all trees within eight months.

The high ringbarking was " light ", i.e. " bark " only was removed in a ring three to four inches wide with a minimum of injury to the sapwood. Ten of the treated trees were left standing for a further period after depletion of the starch. They were co-dominants of the stand—mean G.B.H. 82 in., mean height 94 ft.—with an average, or above average, crown of foliage, and initially possessed a moderate to heavy amount of starch in the sapwood. The mean height of the ringbarking was 31 ft.

Some of these trees died within two months after depletion of the starch. Others died four and six months after starch depletion, while one tree did not die until eight months and one was then still living although its crown of foliage was pale and sparse.

Experiments subsequently carried out on both open forest and scrub species have shown that, in general, trees do not die before depletion of the starch below the ring. Many scrub trees died within a few months after the starch had disappeared, although the period varied up to eight months. Some species of trees are known to be difficult to kill by ringbarking and a study of the starch in these species before and after ringbarking might lead to a more satisfactory ringbarking treatment.

A. R. Brimblecombe
Department of Agriculture and Stock,
Brisbane.

(Received for publication, 18th April, 1947.)

MOLYBDENUM DEFICIENCY IN OATS.

In the Sheffield district of northern Tasmania Algerian oats, when grown on certain well-defined areas, show abnormal growth known locally as " Blue Chaff disease ".

Affected plants show a bluish coloration of the outer glumes, and the grain is pinched. Such crops are therefore usually cut for hay. The remaining stubble on " blue-chaff " areas continues to grow and produces some aftermath. Horses show a preference for the hay from a " blue chaff " area. The chief economic disadvantage in regard to oat growing is that the disease occurs in irregular patches throughout a paddock and if these form a large part of the total area the whole crop must be cut for hay. The disease does not occur every year, but when it does occur it is always found in the same positions even after an interval of several years. Late sown crops of Algerian oats are more susceptible than early sown crops. Responses in pasture growth to molybdenum had been obtained in this district, previous trials with other minor elements having been unsuccessful.

Although the above symptoms are not as severe as those obtained by Piper[2] with solution cultures, the incipient nature of the disease in the field is evident.

Field plots top-dressed with molybdenum on two separate locations on two different properties covering the last two seasons have shown that normal growth occurs where as little as 2 oz. per acre of a soluble molybdate are applied. In the second season, portion of each plot was top-dressed with sulphate of ammonia and no response was obtained. This eliminates the possibility of nitrogen[1] being the factor.

A feature of the trial areas was the marked effect of molybdenum on associated red clover, which is frequently seeded with oats in this part of Tasmania. On one area the molybdenum treated plots received preferential attention from birds, no doubt owing to the better grain formation. The preference of horses for hay from blue chaff areas is probably due to the retention of nutriment in the stems as a result of suspended translocation to the grain. The following analyses were carried out by the Government Analyst's Branch of the Department of Public Health.

TABLE 1.
Molybdenum Content of Algerian Oats.
Sheffield, Tasmania, 1947.

	Molybdenum in Parts per Million.	
	Whole Plant.	Grain.
Control	0·15	0·09 } ±0·03
Treated with Mo (2 ozs. per acre sodium molybdate).	0·30	0·24 }

No evidence of pathogenic organisms was found on samples of affected plants.

The soil on which blue chaff disease occurs is a light red semi-basaltic type such as is found where basaltic soils border on a grey podsolized soil. It falls into the group described by Stephens[3] as a Transitional soil.

E. F. FRICKE.

Department of Agriculture,
Tasmania.

References.

1. Anderson, A. J., and Oertel, A. C. : Coun. Sci. Ind. Res. (Aust.), Bull. 198, 1946.
2. Piper, C. S. : J. Aust. Inst. Agric. Sci., 6 : 162-4, 1940.
3. Stephens, C. G. : Coun. Sci. Ind. Res. (Aust.), Bull. 108, 1937.

(Received for publication, 18th April, 1947.)

"HOLLOW HEART": AN ABNORMAL CONDITION OF THE COTYLEDONS OF *PISUM SATIVUM* L.

Samples of seed of garden and canning peas examined in this laboratory have been found to show an abnormal condition of the cotyledons, which can only be detected if the two cotyledons are separated. This condition, which has been called " hollow heart ", takes the form of a cracked or sunken area in the centre of the adaxial surface of the cotyledon, accompanied occasionally by discoloration and apparent necrosis (Figure 1).

Figure 1.
Pea seedlings with cotyledons separated, showing " hollow heart " condition.

The seeds with this abnormality are normal in outward appearance, and germinate well both in the laboratory and in the field. In the incubators the seedlings are strong and healthy, and do not differ in vigour or appearance from seedlings produced from normally developed seeds. Under controlled conditions in soil tests, however, plants grown from these abnormal seeds are at first smaller than plants from normal seeds.

After investigation, Dr. Lilian Fraser, Plant Pathologist of this Department, has reported that the condition was not caused by pathogenic organisms, nor does it resemble the " marsh spot " type of breakdown. Moreover, it seems unlikely that " hollow heart " is the result of soil deficiencies, because it occurs in samples of seed from U.S.A., New Zealand and various States in this country and from all parts of New South Wales. The percentage of " hollow hearted " seed varies from sample to sample, sometimes reaching the high figure of 60. Samples containing 30 per cent. to 40 per cent. of affected seed are not uncommon.

Experiments have been conducted to determine by various degrees of mutilation whether the reduction in size of plants produced by " hollow hearted " seed is due merely to the amount of mechanical damage sustained. The results are shown in Table 1. The seed used in these tests was from a commercial consignment of New Zealand grown " Greenfeast ", a variety very commonly grown here for the green pea market. One-half of the seed was dusted with Spergon, the active principle of which is tetrachloro-p-benzoquinone, the other half was left undusted.

TABLE 1.

Dry Weights of Plants Grown from Seedlings with Sound and Damaged Cotyledons.

	Untreated. C.gm.	" Spergon." C.gm.	Mean. (S.E.±6·7.)
1. Sound cotyledons	147·0	155·0	151·0
2. Half cotyledons	94·0	109·0	101·5
3. No cotyledon	15·0	14·0	14·5
4. Hollow hearts	90·0	92·0	91·0
Mean (S.E.±4·75)	86·5	92·5	89·5

S.E. for interaction, ±9·5.

The seedlings were then planted in sterilized soil in pots (five plants per pot with four replications). They were grown for one month, then harvested and the tops dried and weighed. The mean weights for each group are shown in Table 1.

Dusting with " Spergon " did not have any appreciable influence on final weights in this test, but in other tests it was decided that the more vigorous growth of plants from " Spergon "-dusted seed (as compared with untreated seed) was due to its protectant quality.

It will be seen that there were significant differences between the mean weights of plants from seedlings with different degrees of mutilation of the cotyledons.

The " hollow heart " seedlings yielded plants of significantly lower weight than did the sound seedlings, and of significantly greater weight than did those in which both cotyledons were removed.

AMY MYERS.

Seeds Officer,
Department of Agriculture,
New South Wales.

The Australian Institute of Agricultural Science

ELEVENTH GENERAL MEETING

Notice.

It has been decided that a general meeting of the Institute will be held at Perth on 18th and 19th August, 1947, immediately prior to the meetings of the Australian and New Zealand Association for the Advancement of Science.

The main business will consist of discussions of Institute affairs ; the draft Agenda, which is still subject to final emendations, includes Salaries and Status, Interchange of Personnel, Institute policy and the financing of Institute activities, the future form and functions of Institute publications and other Institute projects such as the Award of Merit.

F. T. Bowman,
Honorary General Secretary.

TENTH GENERAL MEETING.

This was held at Science House, Sydney, on 21st March, and business was confined to the receipt of reports from the Council, a statement of accounts and the balance sheet and reports concerning the Journal. The report of Council for 1946 appears below, the audited statement of accounts on p. 81, and the Hon. Editor's report concerning Volume 12 on p. 80.

It was also reported to the meeting that Council had unanimously elected Mr. G. de Vahl Davis as President of the Institute for the ensuing period. At the conclusion of the formal business the retiring President, Dr. B. T. Dickson, delivered an address entitled " Two Decades—a Review of the Agricultural Set-up, 1926-1946 ". It is published at the beginning of this volume.

Report of Council for 1946.

Your Council has pleasure in presenting its report for the year ending 31st December, 1946, that is to the end of the twelfth year of Institute activity.

The office-bearers for the year were as follows :

President : Dr. B. T. Dickson.

Hon. General Treasurer : Mr. F. C. McCleery.

Hon. General Secretary : Dr. F. T. Bowman.

Asst. Secretary : Mr. E. J. Waring.

Delegates :

Qld. Branch : Mr. O. St. J. Kent (succeeded by Mr. D. O. Atherton). Proxy, Dr. N. S. Noble.
N.S.W. Branch : Dr. E. T. Edwards. Proxy, Dr. N. S. Noble.
A.C.T. Branch : Mr. C. M. Donald. Proxy, Prof. J. R. A. McMillan.
Vic. Branch : Mr. J. O. Baker. Proxy, Mr. H. J. Geddes.
Tas. Branch : Mr. T. D. Raphael. Proxy, Mr. R. H. Anderson.
S.A. Branch : Dr. H. G. Andrewartha. Proxy, Dr. H. J. Hynes.
W.A. Branch : Mr. C. R. Meadly. Proxy, Mr. G. de Vahl Davis.

During the year Council has noted with pleasure the advancement of many members of the Institute, and has conveyed the congratulations of the Institute to the following members :

Prof. I. Clunies Ross, on appointment to executive, C.S.I.R.
Dr. E. Underwood, on appointment as Professor of Agriculture, University of W.A.
Mr. A. W. S. Moodie, on appointment as Chief, Division of Plant Industry, N.S.W. Department of Agriculture.
Prof. E. Ashby, on appointment as Professor of Botany, University of Manchester.
Dr. A. E. V. Richardson, on appointment as President-elect of Aust. and N.Z. Assoc. for Advancement of Science.
Dr. J. R. A. McMillan, on appointment as Professor of Agriculture, University of Sydney.
Dr. B. T. Dickson, on appointment to Australian delegation to the Food and Agriculture Organization Conference, Copenhagen.

Membership.—The table on the next page shows the number of admissions, transfers and cancellations during the year 1946, as well as the totals for corporate and student membership as at 31st December, 1946.

A rule affecting admissions to membership was adopted in April, to the effect that an applicant approved by Council after 30th September in any year shall have the option of assuming membership either for that year or for the subsequent year.

The Articles of Association were amended at the Adelaide meeting to admit of the conferring by Council of honorary life membership.

Qualifications Committee.—The Qualifications Committee, composed of Messrs. A. J. Vasey (convener), J. A. Aird and G. W. Leeper, has continued to render considerable assistance to Council by its investigation of all applications for membership. During the year the Committee has dealt with 45 corporate and eight student applications for membership.

Corporate Membership.

Branch.	Admissions.	Transfer.		Cancellations and Resignations.	Audited Corporate Membership.	Audited Student Membership.
		Gains.	Losses.			
Qld. ..	2	1	2	—	61	—
N.S.W. ..	12	8	3	4	171	26
A.C.T. ..	4	5	1	1	40	—
Vic. ..	4	3	9	—	149	3
Tas. ..	6	1	2	—	23	—
S.A. ..	7	3	5	—	71	14
W.A. ..	5	1	—	—	72	20
Total	40	22	22	5	587	63

Institute Journal.—Early in the year the issue of the Journal received a setback from the industrial disturbances affecting the printing trade in N.S.W., but the leeway is gradually being overtaken. All reserve stocks of the Journal were transferred to Adelaide during the year. No changes have occurred in the personnel of the Journal Committee, which consists of Mr. D. B. Adam (Editor), Dr. C. S. Piper (Business Manager), Dr. Marshall, Dr. H. G. Andrewartha and Mr. K. Woodroffe.

Branch Activity.—Well attended Branch meetings continue to be a feature of Institute activity. Besides meetings for the discussion of topics of current agricultural interest, Branches have been called upon to devote a good deal of time to business originating from general meetings of the Institute.

Eighth General Meeting.—This meeting was held on 8th March, 1946, for the transaction of formal Institute business : to receive the reports of Council and of the Editor and Business Manager of the Journal, the statement of accounts and balance sheet, and the report of Council concerning the election of President. This business was followed by an address by the President, Dr. B. T. Dickson, on " Trends in Agriculture as the Result of War ".

Ninth General Meeting.—This meeting was held on 19th and 20th August, 1946, at the Waite Agricultural Research Institute, Adelaide, and immediately prior to the meeting of A.N.Z.A.A.S. The Hon. General Secretary and the Hon. General Treasurer also acted as delegates of the Institute to the General Council of A.N.Z.A.A.S. It should be recorded that during the period a project, sponsored in its initial stages by the Institute, was brought to fruition, namely a Conference of Cereal Geneticists and Plant Breeders, which was attended by representatives of all States and the Commonwealth. Subsequent action by Council on the resolutions of the ninth general meeting is as follows :

Awards of Merit. A council sub-committee has made the recommendation that the Institute should make an annual award of a bronze medal for outstanding agricultural research. The terms of this recommendation are at present being considered by Branches.

Financial Position of Institute. Consideration is being given to the ways and means by which the financial resources at the disposal of Council may be built up, in order that the requisite finance may be available to pay expenses of delegates to general meetings of the Institute, and to provide the additional clerical assistance which has become necessary through the increase in the activities of the Institute.

Research Co-ordination and Extension Co-ordination. It is understood that largely owing to the representations of the N.S.W. Branch, the N.S.W. Government favours the setting up of a body for the co-ordination of the research activities of the different organizations operating in the State. Some definite indication of the nature of this body is required before Branches will be requested to make suggestions for their territories on this project.

Salaries and Status. A Council sub-committee is collating information on salaries and status changes since the Adelaide meeting, preparatory to submitting a memorandum to Council for the use of Branches, as required by the pertinent resolution.

Facilities for Interchange of Personnel. Investigations are being made by a Council sub-committee in order that the general desirability of freedom of interchange of personnel, and factors operating against the same, may be brought to the notice of appropriate organizations and authorities.

Proposed Australian Journal of Agricultural Research. The Institute is making enquiries as to the ways in which it may be associated with a proposed national journal of agricultural research, the publication of which is contemplated by C.S.I.R.

Sponsoring of Conferences. Owing to the success of the Cereal Geneticists and Plant Breeders' Conference, Council has adopted the view that other conferences that may be suggested should be sponsored along similar lines to that adopted for the Cereal Breeders' Conference.

Implementation of Institute Policy. Branch opinion and suggestions are being sought on this question.

Progress of Other Projects.—*Teaching and Research in Science.* The Institute is represented by Dr. K. Forster, Victorian Branch, on a joint committee of professional and scientific societies, which has approached the Commonwealth Government on the need for improving facilities for teaching and research in science.

Australian Veterinary Association Resolution on Professional Positions. The Institute advised the Australian Veterinary Association of its support for a resolution which was subsequently brought to the notice of employing authorities to the effect that all professional and scientific vacancies should be advertised and the transfer from one organization to another with rights and privileges should be facilitated.

School of Horticulture. A proposal, originating from the Tasmanian Branch, for improved training in horticulture at universities and colleges is still being considered by some branches.

Tropical Research Station. The Western Australian and Queensland Branches have reported on this proposal and the report of the C.S.I.R. survey of northern Australia is awaited before further action on the part of the Institute is contemplated.

Higher Appointments Office. During the year the Higher Appointments Office, Commonwealth Department of Labour and National Service, requested the co-operation of the Institute. At the request of Council, most Branches have nominated a member to act as a liaison officer to the State branches of the office, and the Hon. General Secretary was nominated as the liaison officer to the central office.

Climatological Data. The Institute has been requested by the Director, Meteorological Branch, Department of Interior, to comment on a programme of climatological mapping, and a report incorporating Branch views is in course of preparation.

Termination of Man Power Advisory Committees. In August the formal winding-up of Man Power Advisory Committees took place, and the Directorate of Man Power forwarded letters of appreciation for services rendered to Council and Branch members who had been associated in the work.

Payment of Rebates to Branches.—Council approved of the payment of rebates to Branches for the year 1945 at the usual rates, viz. 5*s.* 6*d.* for each financial corporate member and 2*s.* 6*d.* for each financial student member.

Report of Editor for Volume 12 (1946).

Volume 12 is the first complete volume handled editorially in Adelaide and published in Sydney. Unfortunately this new arrangement has met with difficulties during almost the whole period of its currency, and these have been reflected by delays in publication. A major cause of delay was the occurrence of a protracted industrial dispute in N.S.W. which held up the production of Part 4 of Volume 11 for a long period. In an effort to get back to the scheduled months of publication, Numbers 1 and 2 of Volume 12 were combined to form one number, but the effort to restore our time-table has not yet been successful.

There are 164 pages in Volume 12, and it is therefore smaller than Volume 11, which contained 204 pages. The various sections of the Journal have been maintained in accordance with previous practice, and the space devoted to Technical Notes and affairs of the Institute for Volume 12 was much the same as for Volume 11. Most of the reduction in size, then, was due to a reduction in the number of articles of general interest. This is to be deplored, since it is articles of this kind which meet the widest need and are likely to be most widely read. The opportunity which the Journal provides for members to publish their views and opinions on agricultural affairs has been stressed on a previous occasion, and it is to be hoped that more members will avail themselves of their opportunities.

THE AUSTRALIAN INSTITUTE OF AGRICULTURAL SCIENCE.

Income and Expenditure Account for the Year Ended 31st December, 1946.

EXPENDITURE.

1945. £ s. d.		£ s. d.	1946 £ s. d.
8 8 0	To Audit Fees		8 8 0
32 15 3	,, Council Meeting Expenses		46 2 3
90 6 6	,, Cost of Journal		298 19 5
	,, General Meeting Expenses—		
	Eighth General (Sydney)	9 14 9	
	Ninth General (Adelaide)	38 0 8	
232 2 10			47 15 5
33 4 2	,, Petty Cash and Incidentals		36 1 3
4 10 0	,, Printing and Stationery		34 0 9
	,, Grants to Branches—		
36 11 6	Victoria	37 10 0	
53 13 0	New South Wales	54 12 0	
18 18 6	South Australia	19 10 0	
11 16 6	Queensland	13 9 6	
12 12 6	Western Australia	28 15 6	
9 12 6	Australian Capital Territory	9 18 0	
6 17 6	Tasmania	6 1 0	
			169 16 0
£551 8 9	,, Total Expenditure for the Year		£641 3 1

INCOME.

1945 £ s. d.		£ s. d.	1946 £ s. d.
	By Subscriptions Received—		
121 18 9	Victorian Branch	143 11 0	
168 8 0	New South Wales Branch	178 10 0	
64 0 0	South Australian Branch	68 7 0	
40 19 0	Queensland Branch	48 6 0	
65 4 0	Western Australian Branch	77 16 0	
31 10 0	Australian Capital Territory Branch	35 14 0	
25 4 0	Tasmanian Branch	24 3 0	
			576 7 0
9 7 6	,, Interest Received		13 0 0
526 11 3	,, Total Income for the Year		589 7 0
24 17 6	,, Deficit for the Year		51 16 1
£551 8 9			£641 3 1

Balance Sheet as at 31st December, 1946.

LIABILITIES.

1945 £ s. d.		£ s. d.	1946 £ s. d.
	Sundry Creditors—		
	Branch Grants	156 18 0	
62 18 0	General	8 8 0	
			165 6 0
6 6 0	Subscriptions Paid in Advance		16 16 0
	Accumulated Fund—		
	Balance at 31/12/1945	789 2 10	
	Less Deficit for year ended 31/12/1946	51 16 1	
789 2 10			737 6 9
£958 6 10			£919 8 9

ASSETS.

1945 £ s. d.		£ s. d.	1946 £ s. d.
	Cash at Bank and in Hand—		
	Sydney	488 18 11	
	Adelaide	16 6 7	
	Petty Cash	2 15 9	
549 1 10			508 1 3
	Commonwealth Government Bonds—		
100 0 0	3½%—15/ 8/1956	100 0 0	
100 0 0	3½%—15/11/1958	100 0 0	
200 0 0	3½%—15/ 9/1959	200 0 0	
			400 0 0
9 5 0	Office Furniture		11 7 6
£958 6 10			£919 8 9

The above Balance Sheet has been prepared from the books of account, accounts and vouchers of The Australian Institute of Agricultural Science and is a correct statement of the position of the Institute's affairs on the 31st December, 1946, as disclosed thereby.

Prudential Building,
39 Martin Place,
Sydney.
4th March, 1947.

HORLEY & HORLEY,
Chartered Accountants (Aust.).

If we look at the contributions to Volume 12 in relation to the Branches to which the authors concerned belong, wide differences are evident. The largest Branches are by no means the heaviest contributors ; some others, unfortunately, contribute very little. However, no criticism of Sub-Editors in the various Branches is to be implied. I am very grateful for the helpful assistance which each one of them gives and desire to express thanks to them. I am also greatly indebted to colleagues on the Publications Committee in Adelaide who have helped to share a burden which was a novelty for us all.

MEETINGS OF COUNCIL.

Meetings of Council were held on 3rd December, 1946, 4th and 25th February, and 1st April, 1947. The first three meetings took place prior to the tenth general meeting and various items discussed or settled at these meetings are covered by the report on p. 79. At the April meeting the new President, Mr. de Vahl Davis, took the chair. Messrs. J. M. Vincent (Qld.), H. P. Brown (S.A.) and F. C. Butler (W.A.) succeeded Drs. N. S. Noble, H. J. Hynes and Mr. de Vahl Davis respectively, as proxy delegates for the Branches indicated. Dr. E. T. Edwards (N.S.W.), as a principal delegate, Prof. J. R. A. McMillan (A.C.T.), Messrs. H. J. Geddes (Vic.) and R. H. Anderson (Tas.) continued to act on the Council with Dr. F. T. Bowman (Hon. Gen. Secretary) and Mr. F. C. McCleery (Hon. Gen. Treasurer).

Council had before it the report of a sub-committee which had been asked

(*a*) to draw up a budget for 1947-48 based on current arrangements ;

(*b*) to prepare estimates of the cost of necessary secretarial assistance, travelling expenses of principal delegates to general meetings and for the proposed award of merit.

Council approved the expenditure of £65 per annum for skilled secretarial assistance for the Hon. Gen. Secretary. This involves an additional expenditure of about £44 per annum. As a consequence of this approval Mr. H. J. Kefford was appointed for a trial period of three months. Council also resolved that no allowance towards the fares of principal delegates to the eleventh general meeting be made.

Members of the Publications and the Qualifications Committee constituted in Adelaide and Melbourne respectively were re-elected. Council agreed to support representations made to the Postmaster-General by the Director and Government Botanist, Melbourne, for the issue of a postage stamp commemorative of the achievements of Baron Sir Ferdinand von Mueller, whose contributions to Australian botany for 50 years are so well known. The centenary of " the Baron's " arrival in Australia will be celebrated in December this year.

Support was also given to an approach by the joint Standing Committee of Scientific Societies to the Prime Minister on the matter of income tax on scholarships.

Membership. Since our last issue Council has taken the following action :

(*a*) Admitted Mr. A. J. Vasey to honorary life membership in recognition of his valuable services during the formation of the Institute and the subsequent ten-year period during which he was Hon. General Secretary.

(*b*) Resolved that financial members of the Institute be granted honorary membership during their period of absence abroad in the tenure of a travelling research scholarship. Under the terms of this resolution the following members of the N.S.W. Branch were granted honorary membership while overseas : Messrs. E. P. Baker, K. O. Campbell, F. C. Milthorpe, D. B. Duncan, R. J. Swaby and V. M. Lewis.

(*c*) Admitted to corporate membership Miss M. M. C. Mills (A.C.T. Branch), G. K. Adkins, Miss E. M. Meldrum, W. F. Owens, W. V. Single, L. M. Ward (N.S.W. Branch), F. Chippendale, J. F. Miles, D. Rosser (Qld. Branch), P. C. Angove, H. T. Hughes, J. D. McAuliffe (S.A. Branch), J. T. Kelly, R. J. Veale, J. H. Wilson (Tas. Branch), L. H. P. Jones, R. A. Mullett (Vic. Branch), W. P. Cullinane, J. P. Eckersley, G. T. Halpin, H. L. Pennington, E. R. Watson (W.A. Branch).

(*d*) Admitted to student membership Miss V. H. Box, E. Halpern, M. F. Robins, Miss R. J. Smith, G. W. Spencer (W.A. Branch).

MEETINGS OF BRANCHES.

Australian Capital Territory Branch.

The sixty-second general meeting of the Branch was held on 6th November, 1946, when the main business of the meeting was an address by Dr. F. Clements on " Some Points, Gathered at Home and Abroad, on the Inter-relation of Nutrition and Soil ".

The speaker drew attention to the immaturity of the science of nutrition. It is so new that the present leaders in the field are self-taught and conditioned largely by the field from which they entered into the study of the science.

Bio-chemistry used to be dominant, but this conception has broadened considerably in the last few years to embrace production, distribution and marketing as well as consumption.

The World Food Organization aims at producing sufficient food for the world. Asia's problem is quantity of food and Australia will be looked to to fill the demand at a low price with cereals and fats of animal and vegetable origin. The need for vitamins exists but is not so imperative as the need for calories. Their proteins are also deficient in quantity and mainly of plant origin.

In Australia there are rare self-inflicted instances of starvation, but there is no reason for its occurrence at all. With the possible exception of the United Kingdom, Australia and New Zealand are among the best fed nations of the world. The principal deficiencies in the Australian diet are vitamin B_1 and calcium. Calcium deficiency is a problem for education, not agriculture. The vitamin B deficiency is due in part to the processing of wheat and in part to poor quality wheats. High protein wheats have a higher B_1 content, and a higher percentage of recovery. In some places, vitamin C deficiency is a problem. Goitre is prevalent in Gippsland and is now known to be due to a deficiency in milk and food. There is an unconfirmed report that where superphosphate is used the goitre incidence is less, the association perhaps being in the iodine content of superphosphate.

Virtually nothing is known of the role of trace elements in humans. No diseases have been attributed to deficiencies, but such are possible.

The speaker, in concluding, referred to the possibility of exhaustion of soil nutrients, particularly minor elements in an exploitative agriculture.

The twelfth annual general meeting of the Branch was held on 26th March, 1947. The election of officers resulted as follows :

President : Mr. W. Hartley.

Hon. Secretary : Mr. A. J. Anderson.

Hon. Treasurer : Mr. T. G. Campbell.

Journal Sub-Editor : Mr. G. A. H. Helson.

Committee Member : Mr. C. M. Donald.

Delegate : Mr. W. Hartley.

The retiring President, Mr. C. M. Donald, gave as his Presidential Address an account of " Pasture Investigation in Australia ".

New South Wales Branch.

At a meeting on 11th October, 1946, three entomologists who had been connected with the army gave talks on various aspects of medical entomology in the south-west Pacific. Mr. R. N. McCulloch spoke on the development of materials for the control of *Trombiculid* mites, a problem which assumed great importance in 1943 on account of their relation to the spread of scrub typhus. In 1942 investigations had been commenced on the use of dimethyl phthalate as a mosquito repellent for protection against malaria. Similar work in Florida had shown that dimethyl phthalate when applied to clothing gave very good control of *Trombiculid* mites or chiggers. But dimethyl phthalate was scarce and there was little chance of its becoming available for treating clothing. Attention was then turned to dibutyl phthalate, which, while a poor mosquito repellent, was quite as good as the dimethyl derivative for mite control. Scarcity of phthalate supplies and their important alternative use as a mosquito repellent temporarily diverted interest to the possibilities of using D.D.T. However, it was found meantime that dibutyl phthalate was remarkably persistent in the face of repeated launderings and it was reallocated to mite control. After extensive investigations, the first instructions for the use of anti-mite fluid were drawn up in November, 1943. The dosage was one fluid ounce per set of clothes, distributed as equally as possible and rubbed in by hand. Treatment was to be repeated after seven cold washes of the clothes or fortnightly. Each man received three ounces of anti-mite fluid per fortnight. The effectiveness of the treatment is shown by figures for the cases of scrub typhus. In 1943 there were approximately 1,900. For the eighteen months ending December, 1945, this number was reduced to about 200.

Mr. A. N. Johnston spoke on the organization of malaria control in the army. This service was initiated late in 1942, when the malarial infection in troops had reached alarming figures. The administrative set-up provided for a malariologist whose job included the integration of malaria control measures and the treatment of malarial patients. Mobile entomological units in charge of entomologists conducted surveys and biological studies, determined vectors and investigated control measures. Control units were concerned with the actual measures taken.

While the necessity for control measures was usually apparent from local history or recent experience, the general problem was always viewed from three aspects and control measures were worked out on the aspect likely to give the quickest and most reliable control. The three aspects calling for study were the source of infection, the vector mosquito and the susceptible population of troops. An example of control by attention to sources of infection was provided

in the case of the Northern Territory when it was realized that the absence of a major source of infection was the only circumstance preventing the area from becoming favourable for malaria infection. The policy pursued was to eliminate all troops likely to be " gametocyte carriers ".

The vector mosquito in the south-west Pacific area was *Anopheles punctulatus*, with two subspecies, *farauti* and *punctulatus*. Their control required a study of the bionomics of the species.

The general scheme of control involved active control measures within a radius of one mile of either the major source of infection or the major troop concentration. Measures were taken against adult mosquitoes in the neighbourhood of recently reported cases, while breeding grounds were treated regularly with D.D.T. or more permanently by the construction of drains, etc.

Mr. D. J. Lee dealt with dengue fever, with particular reference to its mosquito vector in New Guinea. Cleland, Bradley and Macdonald (1916, 1918) proved that *Aëdes ægypti* was a vector of dengue fever by having infected mosquitoes sent from Brisbane to Sydney, where they were allowed to infect volunteers in a dengue-free area. A similar experiment between Sumatra and Holland established the fact that *Aëdes albopictus* was also a vector. When a disease which was indistinguishable from dengue fever occurred in the New Guinea campaign, observations by army entomologists suggested that a vector other than those mentioned was concerned. Three experiments during 1943-44 involving the use of eleven different species eventually revealed that *Aëdes scutellaris*, a common mosquito in New Guinea, was a highly efficient vector of the disease. The elucidation of the New Guinea vector of dengue, like that of the first-known vector, was an entirely Australian research project and was carried out under the plan and direction of Lt.-Col. Mackerras.

At a meeting held on 5th December, 1946, Mr. H. K. Gardiner addressed members on the subject " An Australian Farmer's Observations on American Crop and Livestock Industries ".

Queensland Branch.

The twelfth annual general meeting of the Queensland Branch was held in March, when the following Committee was elected : President, Mr. D. O. Atherton ; Vice-President, Mr. A. R. Brimblecombe ; Hon. Sub-Editor, Mr. C. G. Hughes ; Hon. Secretary-Treasurer, Mr. C. W. Winders ; Committee, Messrs. P. J. Skerman, W. J. S. Sloan and C. R. von Stieglitz. The financial statement presented showed that the Branch had an excess of assets over liabilities of £86 19*s.* 5*d.*, which included war saving certificates valued at £43 6*s.* 3*d.* There was no presidential address, since the President for the major portion of the year, Mr. O. St. J. Kent, left Queensland last November to take a position in Victoria. In lieu of this address several members presented notes to the meeting. The President gave a short account, supported by photographs, of his impressions of the possibility of agricultural development in the Gulf country. Mr. C. R. von Stieglitz presented a note on the exhibition of scientific equipment which he had seen in Melbourne earlier in the year. Mr. E. B. Rice outlined the principles and method of the Resazurin Test for milk quality, emphasizing the rapidity with which results could be obtained. Mr. A. R. Brimblecombe presented a note (published on p. 74 in this issue) on starch depletion and death of spotted gum trees.

The congratulations of the meeting were extended to Dr. I. M. Mackerras on his recent appointment as Director of the Queensland Institute of Medical Research, while the new Professor of Agriculture at the Queensland University, Dr. L. J. H. Teakle, was welcomed.

Tasmanian Branch.

At the annual meeting Mr. L. Miller was elected President and Council Delegate for the ensuing twelve months.

The retiring President, Mr. F. E. Ward, reviewed the activities and objectives of the Branch during the past year and indicated certain lines for future consideration.

Reference to records showed increased interest and attendance at meetings. One member was lost through transference to New South Wales and six new members were enrolled.

Victorian Branch.

On 20th December Mr. H. A. Mullett, Director of Agriculture, addressed the Victorian Branch on " Impressions of a Visit to the United States of America, Canada and Denmark ". He was impressed particularly with the high standard of agricultural education and research in the United States, where every State had at least one agricultural university well staffed and efficiently equipped. The tremendous county agent system—California, for example, had 360 agents—provided an excellent farm service. Work on animal husbandry and plant breeding was well advanced. He referred especially to controlled crossing of different breeds of dairy cattle and the beet-mangold cross developed in Denmark and containing more dry matter and less moisture than the ordinary mangold. If it were possible to increase the number of plant breeders at work in this country it would pay handsome dividends. Such problems as soil fertility and erosion

control were being tackled on a vast scale, while mechanization was being applied to all types of farming. In his reports to the State and Federal Governments Mr. Mullett will deal in greater detail with the above matters and the question of soya bean utilization in Australia.

On 7th March Mr. G. C. Howey, member of the Australian Dairy Produce Board, spoke on his recent trip abroad on behalf of the Federal Government and the industry. He said that the average sized herd in America was fifteen, and dairying there was not a specialized undertaking. The cost of producing a pound of butter was about twice that in Australia. Delivery to factories comprised 90 per cent. whole milk, compared with 50 per cent. in Victoria. Americans had made an impressive, if costly, attack on stock diseases, he continued, and over a period of 20 years their incidence had dropped to 0.2 per cent. The Danes, too, had done well in this respect. Rapid strides had been made with artificial insemination and there was no hesitation to breed to close blood lines if a sire proved a good one.

Britain had increased her milk consumption by 50 per cent. and she needed another million cows to cater for her requirements if she were to maintain this rate. It had been proved by Hammond that feeding cows well before calving had a tremendous influence on total production. Mr. Howey also referred to the practice of inserting hormone tablets into the necks of heifers to stimulate lactation without getting them in calf.

The speaker said that we would have to interest ourselves in building up soil fertility through the medium of stock. Some Continental farms had had their capital value increased from £3 to £40 an acre by this method. There was a tremendous lack of trained men who could devote their life to the dairy industry. It would be a good investment for the Government to send men overseas from selected spheres. Many practices abroad were no longer experimental and men should be able to go abroad, see how things were done, bring back the best ideas and put them into practice in Australia.

Western Australian Branch.

At a meeting held on the 6th December, 1946, a discussion on " Research Behind Land Use Planning " was led by Mr. G. H. Burvill and Miss S. Rowley.

In opening the discussion Mr. Burvill said that regional planning first required that the boundaries of regions be defined : a region was an area having physiographic, social and economic entity.

To be able to do this much information was required about the physical resources, markets, communications and other social benefits. As agriculture was the main interest in Western Australia it was pertinent to consider this aspect.

On the whole, climate and soil type were the main factors. The soil pattern due to sandy and lateritic remains of past climatic eras was very complex. In the south-west of the State effective rain fell between May and October, and temperatures were low during that period, though not, of course, too low to inhibit plant growth. In the more northern portions of this region the higher spring temperatures reduced the efficiency of the rainfall.

Miss Rowley, when dealing with the economic aspects of regional planning, said that the economist could best play his part in a team engaged in land-use studies by measuring and interpreting farm production functions.

As an illustration she gave a brief historical description of five regions in which economic surveys had been conducted, viz. Kojonup-Williams, Avon Valley, Margaret River-Nannup in W.A., and the Berriquin and Murrumbidgee Irrigation Areas in New South Wales.

A table presenting some of the results of these surveys contained information regarding total area, number of holdings, effective farm size, land class, rainfall, labour units and several other factors. Some idea was also given of the types of questions which economists ask, such as the proportions in which factors of production are used, which factors are limiting, and how the factors are measured.

Miss Rowley, in conclusion, claimed that accurate production should be the final outcome of economic investigations in land-use.

At a general meeting on 26th March an address was given to members and visitors by Mr. John Green, Director of Farming and Gardening Services of the British Broadcasting Corporation. Mr. Green's address dealt with some general impressions of farming, with particular reference to its social aspects.

Two to three hundred years ago more people were engaged in agriculture than in any other single industry, but since the Industrial Revolution this has been completely altered. In former days the whole community supported itself, but now the farming community has to support the secondary industry as well as itself.

The advent of the internal combustion machine revolutionized industry and this advent, together with other technical advances, means that agriculture is facing a new revolution. Though the interests in land have a great political power, agriculture today no longer occupies a strategic position in the economic system. The townsman does not regard agriculture as important until

food is short or expensive. But agriculture is vital to countries like Australia and New Zealand and it is not fully realized that the farmer's business today is most complicated when compared with that of other workers—say miners.

Mention was made of the debt owed by farmers and the community to such men as Jethro Tull and his drill; to Bates and Bakewell in connexion with the breeding of stock.

Today there is a necessity for turning out agricultural students with a high awareness of humanity and alive to agricultural problems. The farm must also be capable of diversification to permit elasticity of production. Monoculture leads to soil exhaustion and then subsides, and that type of farming is unable to stand up to economic adversity.

With regard to Australian farmers they appeared to suffer from lack of labour and, to some extent, capital.

Mr. Green gave a definition of mixed farming as one in which the plough moves over the whole area at some time. Crops change so that soils are not subject all the time to plants which make the same demands on them.

" Store " country, or " range " country as it is termed in U.S.A., was also mentioned. This type of country has deteriorated in all countries, and is exemplified in Australia in the pastoral areas with their reduction in carrying capacity.

With regard to the revolution of farming rotations, it was pointed out that these usually arose from necessity; for instance, ley farming followed the turnip to counter disease in that plant, and regard for the nitrogen cycle was essential in all farm rotations. The importance of subterranean and other clovers in the mixed farm was stressed.

Summing up, the speaker stressed the need for an imaginative approach to farm problems with full realization of the human side.

Current Notes and News

Conservation Authority in New South Wales.

The Government of New South Wales proposes to create a Conservation Authority in that State. This body will include a chairman, a member of the Water Conservation and Irrigation Commission, the Forestry Commissioner, the Director of the Soil Conservation Service, with the permanent head of the Department of Conservation as executive member. Administrative organization of the Department of Conservation will comprise a Minister with powers of direction and approval but who would not sit as a member of the Water Conservation and Irrigation Commission as at present; the permanent head and executive staff, and the proposed Conservation Authority. The powers of the Authority will be State-wide, and will be to initiate, direct and coordinate investigations; to determine the priority and rate of investigations; to ensure a planned development of natural resources of water, soil and forests; and to direct and order the rate of works.

Regional Station in the South-west of Western Australia.

The Council for Scientific and Industrial Research recently announced its intention to purchase a property for development as a Regional Research Station in the subterranean clover belt of the south-west of Western Australia. The most pressing problem of this region is the loss of fertility in ewes grazing on clover-dominant pasture. It is anticipated that this and many other problems related to pasture, soil and animals will be studied at the station. Much of the work will be undertaken in co-operation with the Western Australian Department of Agriculture.

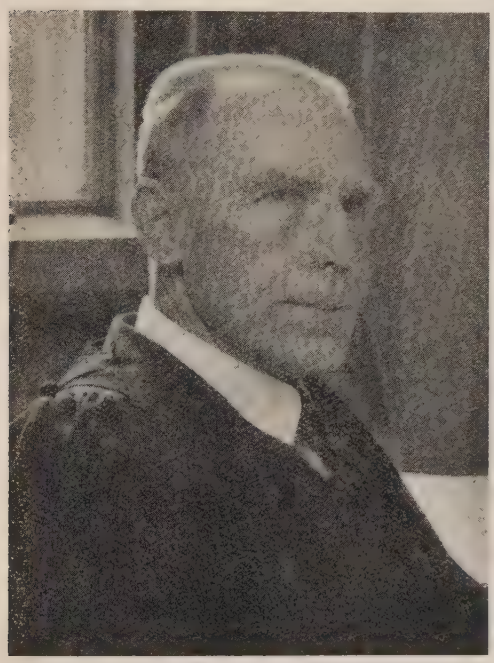
Select Bibliography of Field Farm Surveys.

Professor E. J. Underwood, Director, advises that a bibliography of farm surveys containing some 400 items has been compiled in the Institute of Agriculture, University of W.A., by Miss S. Rowley, B.A., Research Officer in Rural Economics. The five sections of the bibliography cover mapping methods, field-interview methods, account-keeping methods, statistical methods as applied to field surveys of farming and terminology. In selecting references for inclusion the compiler has endeavoured to include all outstanding contributions on method from English-speaking countries overseas and all contributions, whether slight or significant, from Australia and New Zealand. The examples of field surveys are arranged by countries with the object of illustrating the type of work, particularly recent or continuous work, carried out at various centres of research at home and overseas. The Institute of Agriculture is circulating the bibliography in the belief that it will prove useful to officers engaged in field surveys of farming in Australia. Copies will be made available on application without cost.

Robert Dickie Watt.

Professor Watt retired at the end of 1946 after 37 years as Professor and 27 years as Dean of the Faculty of Agriculture, Sydney University. Under his guidance a large and flourishing School of Agriculture has been built up and his influence on agricultural progress in Australia has been great, both directly and through his students, who now occupy many important posts.

Born at Kilmaurs, Ayrshire, in 1881, and educated locally, his first ambition was to follow in his father's footsteps, and for some years he worked on his father's dairy and mixed farm. Later he attended Glasgow University and the West of Scotland Agricultural College, was awarded a Carnegie Research Fellowship, and worked at Rothamsted under Sir Daniel Hall. In 1907 he was appointed Assistant Chemist in the Transvaal Department of Agriculture, and later became Chief Chemist. In 1910 he was appointed to the newly created Chair of Agriculture, Sydney University, the first Chair of Agriculture in Australia. When the Faculty of Agriculture was created in 1920, he became its first Dean. During his tenure of office he has held many important posts. He is a member of the National Research Council, of which he is past Chairman of Executive and now Deputy Chairman. He was a member of the Advisory Council of Science and Industry and of the original executive of that body. He is a member of the Council for Scientific and Industrial Research and was chairman of the N.S.W. State Committee from 1926 to 1942. He is an honorary life member of the Royal Agricultural Society of N.S.W., Senior Trustee of the Public Library of N.S.W., a member of the Linnean and Royal Societies of N.S.W., and of the Australian and New Zealand Association for the Advancement of Science, of which he is a past president of Section K. In 1927 he represented Australia at the Wheat Conference in Rome. He was Chairman of the Murray Lands Commission (Inter-State), which resulted in the foundation of the Coomealla Irrigation Settlement, one of the most successful settlements in the Murray Valley, and also chairman of the " Bunchytop of Bananas " Commission.



Professor R. D. Watt.

Professor Watt was farewelled at a series of dinners tendered by the University Staff, by undergraduates in Agriculture, and by the Sydney University Agricultural Graduates' Association. At this last dinner about sixty graduates were present, and an oil painting of the Professor, together with some personal gifts, were presented by the President of the Association, Dr. F. T. Bowman. The portrait is to be hung in the Faculty Building.

Botany at Sydney University.

Dr. N. A. Burges, University demonstrator and fellow of Emmanuel College, Cambridge, succeeds Professor Eric Ashby as Professor of Botany. He is an Australian by birth, and graduated at Sydney in 1931, after which he began researches in mycology. In 1934 he went to Cambridge as a research student and carried out researches in mycology and plant pathology. He graduated Ph.D. in 1937 and was awarded a Senior 1851 Exhibition. In the following year he was elected a research fellow of his college. Early in the war he joined the R.A.F.V.R. and was attached to the Signals Branch of Bomber Command, retiring in 1945 with the rank of wing-commander. On returning to Cambridge he was made a University demonstrator, assisted in restoring the Botany School to its peacetime activities, and continued his researches, especially on soil fungi and mycorrhiza.

Agriculture at Sydney University.

PROFESSOR R. J. A. MCMILLAN.

Dr. J. R. A. McMillan has taken up his duties as Professor of Agriculture in succession to Professor Watt. His wide experience in agriculture and his personality should fit him well for this important post. After a brilliant university course at Sydney, he was awarded a Ben Fuller travelling scholarship and spent two years studying in the United States, specializing in the genetics and breeding of wheat. He also visited research institutes in England, and on returning to Australia took the position of Plant Breeder and Lecturer in Botany at Gatton Agricultural College, Queensland. In 1929 he joined the Council for Scientific and Industrial Research as principal geneticist. He gained his doctorate in 1937 for research on genetical aspects of wheat crosses. In 1942 Dr. McMillan joined the Commonwealth Department of Agriculture and Commerce to become Executive Officer to the Vegetable Seeds Committee and later Acting Director-General of Agriculture.

Co-ordination of Agricultural Research in N.S.W.

As a result of action taken by the N.S.W. Branch of the Australian Institute of Agricultural Science a Research Advisory Committee known as the Advisory Committee on Co-ordination of Agricultural Research has been established in that State to advise the Government on all questions relating to the initiation and co-ordination of agricultural research.

Nature and Scope of the Committee.

The committee is under the chairmanship of the Chairman of the State Public Service Board, Mr. W. C. Wurth, and comprises

(1) The Under Secretary and Director, Department of Agriculture, Dr. R. J. Noble.

(2) Secretary of Department of Conservation, Mr. C. K. Jacka.

(3) Dean of Faculty of Agriculture, Sydney University, Prof. J. R. A. McMillan.

(4) Executive Officer, C.S.I.R., Dr. I. Clunies Ross.

The Executive Officer of the committee is Dr. H. J. Hynes, Assistant Director, Department of Agriculture.

The committee is thus entirely official, although it has power to co-opt if specialist advice is needed.

The committee is empowered to deal with all laboratory and field agricultural research work which is to be undertaken in the State and also to call for reports on such other matters as may seem relevant. It will meet monthly or more frequently if the need arises.

The Committee will furnish its reports direct to the Premier.

So that the work of the Committee may be effective from the outset, all State Government departments dealing with agriculture, veterinary or forestry work are required to supply the following details to the Committee at the same time as approaches are made to Ministers or the Treasury for funds :

(1) Brief outline and description of project.

(2) Whether existing staff and facilities are adequate, or whether additions are required.

(3) Whether work is being done in co-operation with any other body.

(4) Whether work could be carried out better by some other organization.

(5) Whether project could be extended to meet the needs of some other body, and the most economical way of getting results

In addition all State Government departments concerned with work covered by the Committee are required to list briefly their present regular laboratory and field station activities so that the Committee may be :

(*a*) Fully aware of specific capacity to undertake work.

(*b*) In a position to determine any overlapping or duplication of function.

The Council for Scientific and Industrial Research and the University have been

(1) informed of the Government's desire to co-ordinate all agriculture and forestry research work within the State ;

(2) invited to co-operate and take an active interest ;

(3) keep the Committee informed of all work projected in the fields of activity for which it is responsible, so that duplication and overlapping may be avoided.

Research Professor W. L. Waterhouse.

Research Professor W. L. Waterhouse.

His students everywhere will receive with great satisfaction news of the honour bestowed on Dr. W. L. Waterhouse. His appointment as Research Professor in the School of Agriculture is the first occasion on which such a position has been created in Sydney. His work on the breeding of wheat resistant in particular to the various strains of stem rust and on the nature of these strains has earned for him a leading place amongst the world's plant pathologists. Of no less importance is his work as a teacher, as the number of his students occupying positions of importance bears witness. He has succeeded to a remarkable degree in imbuing them with his enthusiasm and his passion for exact and detailed investigation.

Dr. Kent-Jones Visits South Australia.

Agriculturists, bread manufacturers, flour millers and cereal research workers were the guests of the bread manufacturers of South Australia at the Waite Institute on the 19th March to hear Dr. D. W. Kent-Jones, the English authority on cereal chemistry.

The bread manufacturers of New South Wales had invited Dr. Kent-Jones to visit Australia, his purpose being to advise that body on the establishment of a Baker's Laboratory Service and Research Institute.

The Adelaide conference was opened by the Minister of Agriculture, Sir George Jenkins, who welcomed Dr. Kent-Jones to South Australia and expressed the wish that the conference would be both a happy and profitable one.

Messrs. E. J. Breakwell, of Roseworthy Agricultural College, and A. T. Pugsley, of the Waite Agricultural Research Institute, outlined the recent work in South Australia which had led to the production of several high yielding, high quality varieties of wheat.

Dr. Kent-Jones said that on this second visit after a lapse of sixteen years he was refreshed by the change in outlook as regards quality of South Australian wheat. However, it was disappointing to find that Australia had not yet been able to establish a grading system for the marketing of her wheat. One of the greatest needs of the wheat industry in Australia to-day was the discarding of the F.A.Q. system and its replacement by a system of grading.

Appointment to Chair of Agriculture in Queensland.

Dr. L. J. H. Teakle has been appointed to the Chair of Agriculture in the University of Queensland. Professor Teakle was for nearly 20 years Research Officer and Adviser in Plant Nutrition in the Western Australian Department of Agriculture and more recently Commissioner of Soil Conservation.

Professor Teakle was born in 1901 in South Australia but went to Western Australia shortly afterwards. Matriculating from the Perth Modern School in 1918, he was awarded a Government Exhibition to the University of W.A., where he graduated B.Sc. in Agriculture in 1923 and also won the Amy Saw Scholarship. He joined the staff of the W.A. Department of Agriculture in the same year, but in a few months left for the United States of America to undertake post-graduate work in the University of California. In California he investigated the factors influencing the concentration of phosphate in the soil solution and the composition of wheat under a range of phosphate concentrations in flowing solution cultures and was granted a Ph.D. in 1927.

Professor L. J. H. Teakle.

Professor Teakle has travelled extensively in Australia and overseas and has observed agricultural conditions in the British Isles, North America, France, Belgium, Holland, Germany, Italy and New Zealand.

As Plant Nutrition Officer Dr. Teakle was responsible for the organization and carrying out of soil surveys and research into aspects of soil chemistry and plant nutrition in Western Australia. In 1929, when surveys were in progress of areas proposed for land settlement, reconnaissance work early pointed to the occurrence of a serious soil salinity problem in some of the low rainfall wheat areas. This necessitated a detailed definition of the soils affected, both in occupied country and in territory proposed for settlement. With respect to soil salinity alone, reconnaissances covered about 8,000,000 acres and 1,250,000 acres were classified in detail. Dr. Teakle's report led to the drastic curtailment of this ambitious land settlement project.

Extensive investigations have also been conducted by Dr. Teakle and his associates on the mineral requirements of a wide variety of crops. Publication of the results of these investigations and the work with soil is spread over more than eighty papers. In May, 1946, Dr. Teakle was appointed Commissioner of Soil Conservation and already he has laid the foundations of a Western Australian Soil Conservation Service.

Professor Teakle has taken an interest in a wide range of scientific organizations. He has been Branch President of A.I.A.S. and of the Australian Chemical Institute, and a President of the Royal Society of W.A. He is a Fellow of the American Association for the Advancement of Science, a member of the Australian National Research Council, the American Society of Plant Physiologists, the Australian Association of Scientific Workers, and the Economics Society of Australia and New Zealand.

As a part-time lecturer in the University of W.A., he has conducted and collaborated in courses of Agricultural Chemistry, Soil Science and Physical Chemistry since 1928, and has been a member of the Faculty of Agriculture since its foundation in 1936.

Professor Teakle has always shown a sympathetic appreciation of the problems of students and junior agricultural officers. This, combined with his academic qualifications, his energy and his long experience in agricultural research, extension and teaching, equip him admirably for his new post.

Research on the Testing of Agricultural Machinery.

A sub-committee of the N.S.W. Branch, with Mr. L. Judd as convener, was set up to examine the question of the advisability of providing facilities for research on and the testing of agricultural machinery.

Following deliberations the Committee considers that " Facilities should be provided for research on and testing of agricultural machinery, and considers that Hawkesbury Agricultural College or a similar institution in other States would be the best suited location for carrying out demonstration trials, etc."

In the deliberations attention was drawn to the activities of the National Institute of Agricultural Engineering. It was pointed out that the Institute possessed a personnel of 82 members, comprising scientific 20, industrial 50, clerical and administrative 12. The objectives of the National Institute may be briefly summarized as follows :

(1) Developmental and experimental work.
(2) Testing.
(3) Educational.
(4) General and consultation with machinery firms, confidential trials, etc.

The Committee felt that machinery firms are desirous of manufacturing machines to meet the diversified needs of the farmers, but it is felt machines are often placed on the market prematurely, due in no small measure to the lack of knowledge of the work required for the machine and the conditions under which it is to operate.

It was considered that at the present time we have the position of different manufacturers competing one with another. Machines similar in principle differ in detail or design owing to the acquisition of patent rights and differences in mechanical ideas. Also, farmers purchasing machines in what may be called their experimental stages often incur unnecessary loss and experience unsatisfactory service from these machines. It was felt that consultation with the qualified body together with adequate experimentation, research and testing would obviate the premature marketing of a defective machine and save loss to the farming community.

It was felt well-directed research, experimentation and trial should result in :

(*a*) Considerable improvement to existing machinery.

(*b*) The introduction of greater standardization with consequent improvement to the economics both in the field of production and use.

(*c*) A speedier manufacture and release of specialized machines to handle specialized crops in particular. This would be of extreme importance in substantially boosting production of specialized crops.

The Committee thought that the testing of machines should be efficiently planned and directed and that such testings replace the haphazard field trials which are invariably designed more to impress the farming community and promote sales than to test the efficiency of the machine and its ability to carry out the work required of it.

The Committee recommends :

(1) That a central body should be established on the Commonwealth level.

(2) It is suggested a committee should be appointed comprising the following :
   (*a*) Representatives of manufacturers and distributors.
   (*b*) Representatives of universities.
   (*c*) Representatives of the State Department of Agriculture.
   (*d*) Representatives of the Department of Commerce and Agriculture.
   (*e*) Representatives of the Patents Office.

(3) The abovementioned committee to act as the advisory body to the Government in the formulation of policy in relation to research, experimentation and field trials.

It was considered that the activities of the body be confined to the investigation of existing or new machines about to be put into production and not regarded as a centre to which all inventions would be forwarded as it was agreed that much valuable time of any responsible body may be taken up in attending to what may prove futile suggestions. It was felt that any inventions would very early find their way to machinery firms who would be capable of dealing with this aspect of the work.

It was considered that one of the best means of finance would be through
a grant from the Commonwealth Government, and
a grant from the machinery firms and distributors.

Book Reviews

CROP PRODUCTION AND ENVIRONMENT, by R. O. Whyte.

(372 pp., with 32 plates and 53 text-figures. Faber and Faber Ltd., London, 1946. Price 25/- sterling.)

Dr. Whyte has brought together much interesting and useful information from the work conducted in Great Britain, the United States, Russia and some other countries on the physiological responses of crop plants to physical environmental factors.

The title is somewhat misleading as material concerning the influences of factors relating to the soil, the supply of moisture, competition and the management of farm crops is not included ; the subject matter, in fact, relates principally to the growth and development of crop plants as affected by light and temperature. The behaviour of the plant in terms of its developmental physiology is concerned more than its production ; an exhaustive treatment of the literature covering the relationships of growth and development to both temperature and light is given.

The book, which incorporates 20 chapters dealing with the subject matter indicated, also contains a glossary of terms and bibliographies under each chapter head ; authors' names, genera and species and subjects are separately indexed. The illustrations and text figures are well chosen, and a fruitful source of information resulting from the comprehensive studies of recent years is available to the reader.

The essential distinctions between growth on the one hand and development on the other are stressed throughout. The review commences with the work of Klebs and of Gassner and follows with that of Garner and Allard and of Lysenko, proceeding through the wealth of experiment stimulated by this work and by the reviews of Whyte and Hudson, Maximov and others.

Attention is drawn to the field opened by the development of techniques for the microdissection of growing points, and some good illustrations are given. The investigations of Gregory and Purvis and of Went on the underlying causes of vernalization and optimal thermoperiodicity respectively are treated in some detail.

A section on hormones in relation to growth as distinct from development is included to indicate one aspect of the complex internal make-up of the plant as governed by the operation of the external factors and the hormonal balance within the plant.

The views of Čailahjan, Gregory and Purvis and Hammer on substances of a hormonal nature concerned with flower induction are compared. The book concludes with some information on the physiological responses of specific economic crop plants including the cereals, sugar cane, sugar beet, potatoes, leguminous and vegetable crops, flower crops, shrubs, trees, tropical and subtropical crops. It will serve as a valuable reference guide to future work concerning the developmental physiology of crop plants, of which much yet requires to be undertaken.

There is some lack of continuity, resulting probably from the complexity and incompleteness of much work on the subject. This has also been accentuated by the fact that light and temperature on a periodicity basis form only part of the rapidly fluctuating environment to which the plant is continually exposed. Moreover, environmental effects are now known to date from the fertilization of the ovule and, according to the genetic constitution of the plant, the interactions to the complexes and factors involved may vary widely.

It has taken courage to embark on such a review, the need for which has been evident for some time, and workers in plant physiology and agronomy throughout the world will be grateful to Dr. Whyte for his comprehensive compilation.

H. C. Trumble.

LUTHER BURBANK, A VICTIM OF HERO WORSHIP, by W. L. Howard.

(The Chronica Botanica Co., Waltham, Mass., U.S.A. Melbourne Agents, N. H. Seward Pty. Ltd. Price $3.75.)

This book is essentially the presentation of a series of character sketches of one who in the author's words was " a man of worth, a man of original ideas ; a man with a definite mission in life, fully capable of standing on his own feet as a lone worker in the field of science ". At the same time this man was unfortunately " a victim of hero worship ".

The author's aim is to explain and clarify some of the principal episodes of Burbank's life, and one of the most interesting accounts is that telling of his relations with men of science. Howard traces the development of " the caste system of institutional scientists " from its origins in Germany some 60 years ago to its spread throughout the world of today. Perhaps the major disappointment of Burbank's life was his failure to gain admittance to this caste ; yet Howard rightly claims that Burbank possessed many of the talents and attributes of a conventional scientist. Howard believes that Burbank's greatest contribution from the viewpoint of science was the stimulus that his work gave to the advancement of the science of breeding.

The weaknesses and failings of Burbank can be largely attributed to the fact that he was a nurseryman, choosing to live by the fruits of his own labour. Throughout his life the standard of his ideals and ethics, as well as his showmanship, were those set down by that profession. Such standards still exist in the nursery trade today where standard varieties are renamed and extravagant claims made exactly as they were in Burbank's time.

Chapter XIX is a summary of Burbank's productions, a full report of which has been published as Bulletin No. 691 of the Californian Agricultural Experiment Station.

The book is well produced and includes a number of interesting historical plates and text figures.

A. T. Pugsley.

MERRILLEANA—A SELECTION FROM THE GENERAL WRITINGS OF E. D. MERRILL.

(*Chronica Botanica Co., Waltham, Mass., and N. H. Seward, Pty. Ltd., Melbourne. Price* $4.00.)

This book, which forms Vol. 10, No. 3-4 of *Chronica Botanica*, with 267 pages, contains a full bibliography of the writings of Dr. Merrill, a useful outline of his life, and selections from his own pen.

Merrill's life work has been in systematic and economic botany, including much on grasses. Twenty years of his early career were spent as botanist in Manila, culminating in the publication of his great work " An Enumeration of Philippine Flowering Plants ". He is a world authority on plants of eastern Asia and the East Indies, and more recently has turned to a study of the plants of the Pacific Islands, especially New Guinea and Papua.

" Merrilleana " does not include highly technical articles, but well written accounts of such matters as a scientific expedition in the tropics, much on important domestic plants and their relation to man in Malaysia and the Pacific, an essay dealing with tobacco in New Guinea, another on leprosy and chaulmoogra oil, then several treating of points of general scientific procedure. Some of the selections, such as appraisals of the work of other botanists, and a few dealing with plant-geographical relationships in Malaysia, are more for those with botanical and geological interests.

C. M. Eardley.

FRAGMENTA PAPUANA. OBSERVATIONS OF A NATURALIST IN NETHERLANDS NEW GUINEA, by H. J. Lam, translated by Lily M. Perry.

(*Sargentia, Vol. V. Pp.* 196. *Arnold Arboretum, Harvard University, Mass., U.S.A.* 1945. *Price* $3.00.)

The Arnold Arboretum has fostered, for some twenty years, the arduous and costly work of exploring the vegetation of New Guinea, and many taxonomic accounts appear in its publications.

This translation from the Dutch provides a very interesting account of a well-equipped scientific expedition which during 1920-1922 explored the region behind Cape d'Urville on the north coast of Dutch New Guinea. H. J. Lam is well known as a leading authority on the flora and this narrative is chiefly botanical.

C. M. Eardley.

THE FORAGE RESOURCES OF LATIN AMERICA—EL SALVADOR, by James M. Watkins.

(Bulletin 35, I.A.B. *Imperial Bureau of Pastures and Forage Crops, Aberystwyth, Great Britain. Price* 2s. 6d.)

This is the first Bulletin in what is to be a series on the Forage Resources of Latin America. This publication was prepared in association with the U.S.D.A. and was written by Dr. J. M. Watkins, Senior Agronomist, Office of Foreign Agricultural Relations, U.S.D.A., who is located at present in El Salvador.

The publication outlines the soil and climatic conditions of El Salvador, which has a characteristic tropical climate, the annual rainfall being 75 inches, while most of the soils are of volcanic origin. Dr. Watkins outlines the various forage plants occurring, giving details of their occurrence and economic value to the country. Some 22 grasses and 10 legumes are included, together with an extensive bibliography.

This Bulletin should be of interest particularly to those concerned with the development of tropical parts of Australia.

FUNGICIDES AND THEIR ACTION, by J. G. Horsfall.

(*Waltham, Mass., U.S.A., Chronica Botanica Co.; Melbourne, N. H. Seward.* 1946. *Price.* $5.00.)

The fungicide weapon has enabled mankind over the past sixty years to gain many victories in his fight against diseases of crop plants and their produce. These successes have resulted in untold savings from the widespread use of fungicides for the prevention of leaf and fruit diseases as well as seed and soil-borne diseases of plants, and have stimulated the development of a system of knowledge of fungicides and their uses.

Dr. James G. Horsfall, in an exceedingly human and lucid style which makes for easy reading, brings together in his book, "Fungicides and their Action", this system of knowledge. He presents particularly the principles on which fungicidal action is based as the means of improving field methods, and also stresses the importance of satisfactory techniques for the evaluation of fungicidal efficacy. The subdivision of his subject includes history, general concepts, laboratory assay, data assessment, principles of chemical protection, deposition, coverage, tenacity, artificial immunization and chemotherapy, action of specific fungicidal chemicals, antagonism and synergism and phytotoxicity; the book, however, is in no sense a compendium of practical fungicide schedules.

His literature survey, which is covered by a bibliography of nearly 500 titles, has been thawed and quickened by the treatment of the author, who has himself been actively engaged on research into fungicides for many years, and who has projected his own personality into the style of the book in a way, unusual in the treatment of a scientific subject. This book should stimulate workers in this field of endeavour to develop tools of greater precision with which to probe the fungicidal problems of the future. It should find a very useful place in the libraries of all Plant Pathologists, and should be of great value to teachers of the subject at the university level.

S. Fish.

WHEAT FARMS OF VICTORIA, by A. J. Holt.

(*Melbourne University Press. Price* 10s.)

This little book is a sociological survey in the right scientific tradition.

The young author observes, records, compares and allows himself reasonable comment but remains always a scientist.

The picture he paints of 138 farms selected at random (on a sampling technique presented in his first chapter) is satisfying in that it rings true. It could hardly be otherwise, for it *is* true. It is a depressing picture in some ways—at least depressing to those who want to hold their romantic notion of the sturdy, self-reliant, healthy, high-minded, intelligent country man as the backbone of our State and the highlight of our democracy. Instead we see a well-drawn picture of our democracy with all its dark patches, poverty, prejudices and pettiness. But of course the country folk are happy and vigorous, too, but it is harder to assess the value of the compensations of country life than to record the disabilities.

I enjoyed reading the book and if you are really interested in a worth-while analysis of the material and human environment of the country so will you.

Mr. Holt looks first at the history of settlement, then the farm and its activities, then the people, their homes, their work and their leisure; the social organization and health, then a chapter on attitudes, and finally the summary and conclusion.

He finishes by making some suggestions about possible amelioration of life on the land, especially for the housewife who feels isolation more than her men folk.

The value put by country people on higher education is interesting and encouraging, and although education is likely to take them off the land that can hardly be a bad thing when a constantly decreasing proportion of our people is required to produce food for the rest.

Communal living while working the surrounding country as separate farms seems to give a rich community life to many in France, but it is doubtful if we could organize many districts in that way in Australia.

It was interesting to read of good farmers from South Australia settling in the Victorian wheat belt. They make good settlers from Queensland to Western Australia. They seem to grow good farmers for export in South Australia. We could do with more of them.

The book is well printed and easy to read. I spotted only one printing error, and it bears the stamp of good editing. With the other publication on a survey of rural towns in Victoria, this book adds to the deserved prestige of the Agriculture School of the University and its well-known head. It is a most valuable contribution as a subject which will take a long time to cover adequately. If in the covering we lose some of our cherished illusions, it is all in the interest of greater knowledge and consequently greater power to arrange things for the betterment of this our country.

G. A. Currie.

Personal Notes

Dr. H. J. Hynes, Chief of the Division of Marketing in the New South Wales Department of Agriculture, has been appointed to the position of Assistant Director and Executive Officer of the State Advisory Committee on the Co-ordination of Agricultural Research.

Miss Lorna Byrne spent part of January and February in Tasmania lecturing on women's extension services on behalf of the Tasmanian Department of Agriculture and the Country Women's Association.

Messrs. T. J. Robinson and D. H. Curnow have been awarded Hackett Research Studentships granted by the University of W.A. Both are officers of the Department of Agriculture engaged in study of the sheep infertility problem. Mr. Robinson is going to Cambridge for further research in animal physiology, and Mr. Curnow to London for biochemical research.

Mr. L. C. Lightfoot has been appointed Senior Soil Conservation Adviser in the W.A. Department of Agriculture.

Mr. F. Melville has joined the W.A. Department of Agriculture as Horticultural Adviser.

Dr. L. W. Samuel has been appointed Deputy Government Agricultural Chemist, Government Chemical Laboratories, Perth. He was formerly Cereal Research Officer in the W.A. Department of Agriculture.

Mr. A. V. Hill has returned to Canberra after his visit to the U.S.A., where he was studying problems associated with the tobacco industry. On his way home, he visited the tobacco areas in New Zealand.

Mr. R. L. Crocker, of the Waite Institute, has left for Cambridge, where he will work in the Botany School with Dr. Maskell and Dr. Watt.

Miss Alison Vines has resigned from the Waite Institute and has gone to England.

The appointment of Mr. T. H. Kneen, Victorian Branch Secretary, to the position of Principal, School of Horticulture, Burnley, has been confirmed. He was formerly Senior Horticultural Instructor.

Mr. W. C. T. Major has accepted the managership of the Atherton Tablelands Co-Op. Dairy Association Ltd., Malanda, north Queensland, after ten years' service in the Department of Agriculture as dairy technologist.

Mr. W. W. Bryan has been appointed to the position of Senior Lecturer in Plant Industry at the Queensland Agricultural High School and College, Gatton, and Mr. E. C. Tommerup to that of Lecturer in Agronomy at the same place.

Messrs. J. E. C. Aberdeen and F. Chippendale have been mentioned in despatches for meritorious work in the south-west Pacific area.

Dr. I. M. Mackerras has been appointed Director of the Queensland Institute of Medical Research.

Colonel J. K. Murray recently came down from New Guinea to deliver the Macrossan Memorial Lectures, choosing as his subject " Papua and New Guinea ".

Mr. R. Roe has transferred from Queensland to the regional pastoral research laboratory at Armidale, N.S.W.

Dr. J. Hosking is now Officer-in-charge, Masonry Investigations, Building Materials Research, C.S.I.R., Melbourne.

Mr. L. C. Holmes has resigned his position as Senior Research Officer, Bureau of Agricultural Economics, Department of Commerce and Agriculture, to take up an executive position in the export division of the merchandise department of H. C. Sleigh, 582 Little Collins St., Melbourne.

Mr. C. L. Bangs, who graduated this year with first-class honours in Agriculture in the University of W.A., has been awarded a C.S.I.R. Overseas Studentship and will proceed to the University of California about August. He will engage in post-graduate study and research in plant nutrition and plant physiology under Professor D. R. Hoagland.

Mr. G. H. Burvill, who was only recently appointed Plant Nutrition Officer, has now been appointed Commissioner of Soil Conservation in the W.A. Department of Agriculture.

Mr. K. R. Norris, of the Division of Economic Entomology, C.S.I.R., who recently visited New Zealand at the invitation of the N.Z. Government, to survey areas where outbreaks of the red-legged earth mite had occurred, has been transferred to Brisbane, where he will carry out ecological studies on the cattle tick.

Mr. G. A. H. Helson, of the Division of Economic Entomology, C.S.I.R., has also been to New Zealand, and spent some time at the Cawthron Institute and the Plant Research Laboratory, Auckland.

Mr. C. S. Christian has returned to the Northern Territory to carry out further survey work along the lines of that begun in 1946.

Mr. C. Goldstone, who was stationed at Deloraine, left the Department of Agriculture last month to take up the appointment of Lecturer in Sheep Husbandry at the Massey Agricultural College, New Zealand.

Mr. G. M. E. Mayo has been appointed Assistant Plant Geneticist at the Waite Institute.

Mr. H. T. Hughes has been appointed to the Division of Soils, C.S.I.R., to do soil survey work.

Mr. E. J. Breakwell, of Roseworthy Agricultural College, has taken up an appointment as Senior Lecturer in Principles of Agriculture at the University of Sydney.